Spicer® Tandem Drive Axles

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Sevice Manual

Spicer® Tandem Drive Axles

AXSM-0042

September 2007

Models:

D/R440 D/R460
D/R480 D/R485
D/R461 D/R462
D/R463 D/R521
D/R581 D/R601
D/R651 D/R652
D/R653

Warnings and Caution

The description and specifications contained in this service publication are current and the time of printing.

Dana Corporation reserves the right to discontinue or to modify its models and/or procedures and to change specifications at any time without notice.

Any reference to brand names in this publication is made simply as an example of the types of tools and materials recommended for use and should not be considered an endorsement. Equivalents, if available, may be used.

Important Notice

This symbol is used throughout this manual to call attention to procedures where carelessness or failure to follow specific instructions may result in personal injury and/or component damage.

Departure from the instructions, choice of tools, materials and recommended parts mentioned in this publication may jeopardize the personal safety of the service technician or vehicle operator.

⚠ WARNING

Failure to follow indicated procedures creates a high risk of personal injury to the servicing technician.

⚠ CAUTION

Failure to follow indicated procedures may cause component damage or malfunction.

⚠ IMPORTANT

Highly recommended procedures for proper service of this unit.

NOTE: Additional service information not covered in the service procedures.

TIP: Helpful removal and installation procedures to aid in the service of this unit.

Always use genuine Dana replacement parts.

Table of Contents - Visual

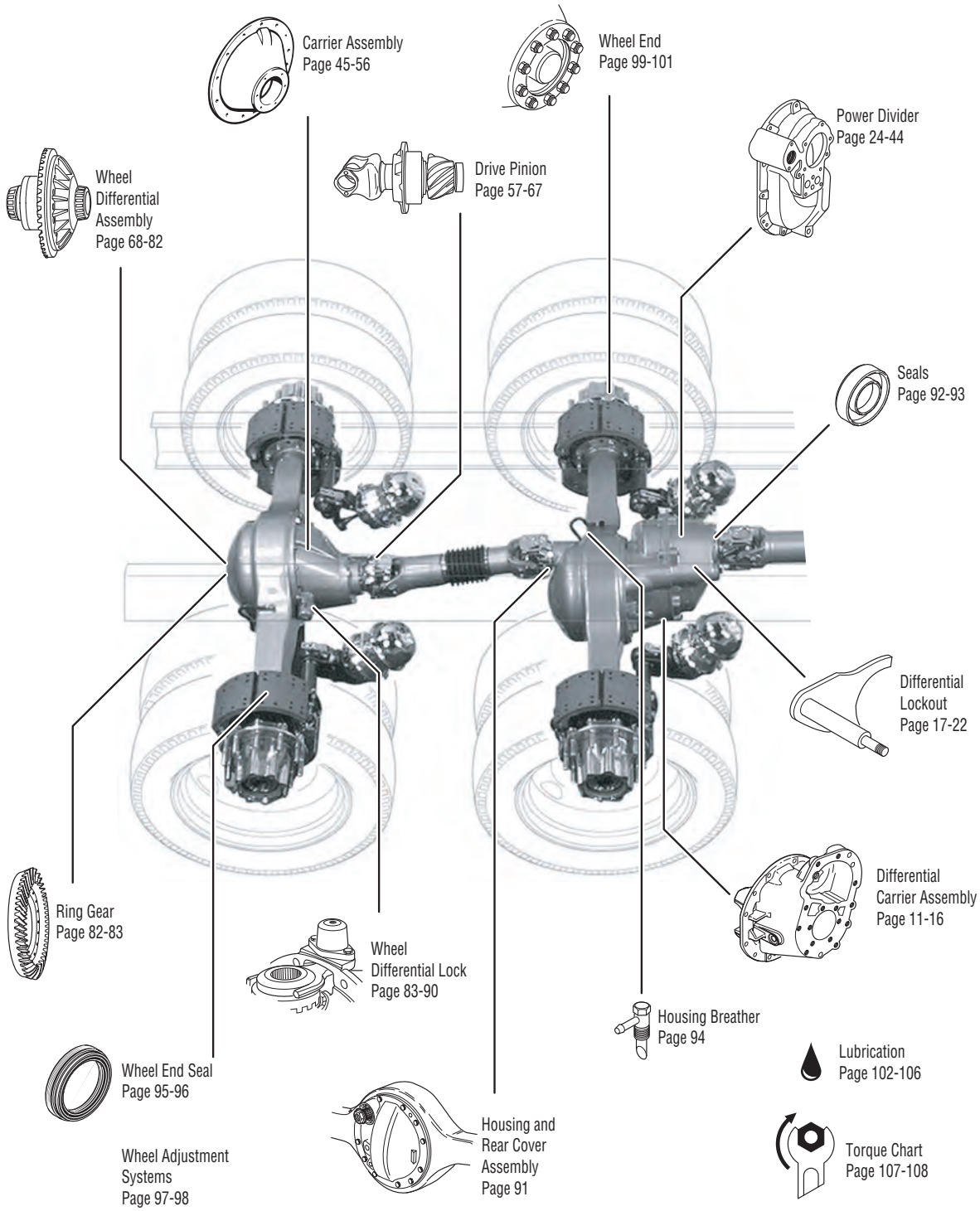


Table of Contents

Introduction 1
Failure Analysis 7
Inspection 9
Differential Carrier Assembly - Parts 11
Differential Lockout 17
Power Divider
- Power Divider - Parts Exploded View 23
- Remove Power Divider 24
- Remove Power Divider from Differential Carrier (with carrier removed from axle housing) 25
- Disassemble, Assemble and Overhaul the Power Divider 27
- Install Power Divider on Differential Carrier (with carrier assembled to axle housing) 38
- Install Power Divider on Differential Carrier (with carrier removed from axle housing) 40
- Dissasemble Differential Carrier (with power divider removed) 54

Drive Pinion
- Drive Pinion - Parts Exploded View 57
- Disassemble and Overhaul Drive Pinion 58
- Install Drive Pinion Assembly 65

Wheel Differential Assembly
- Wheel Differential Assembly - Parts Exploded View 68
- Housing and Rear Cover Assembly - Parts Exploded View 91

Seals 92
Housing Breather 94
Wheel End Seal - Parts Exploded View 95
Remove and Overhaul Wheel End Seal 96
Wheel Adjustment Systems 97
Verify Wheel End-play Procedure 99
Lubricate Wheel End 100
Lubrication 102
Lube Change Intervals 103
Change Lube 104
Standpipes 105
Torque Chart 107
Appendix
- Wheel Differential Lock 109
- Differential Lock Theory of Operation 110
- Control Systems 111
- Dual Range Axle Shift Systems 113
- Troubleshooting 120
- Proper Vehicle Towing 122
- Axle Shift System Components 124
- Inter-Axle Differential Lockout
- With Interlock Control Valve (straight-air type) 126
- Theory of Operation 129
- Power Flow and Torque Distribution 130
- Lubrication 132
- Torque Distribution in Low Range 136

Introduction

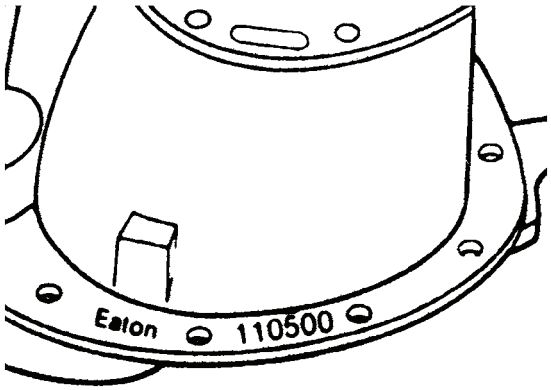
Dana Corporation, Axle & Brake Division, presents this publication to aid in maintenance and overhaul of Dana tandem drive axles. Instructions contained cover the models listed. Their design is common, with differences in load capacity. Capacity variations are achieved by combining basic differential carrier assemblies with different axle housings, axle shafts and wheel equipment.

The suffix letter "P" in the model number indicates lube pump is standard. Pump models are equipped with a gerotor pump, designed to provide additional lubrication to the inter-axle differential and related parts.

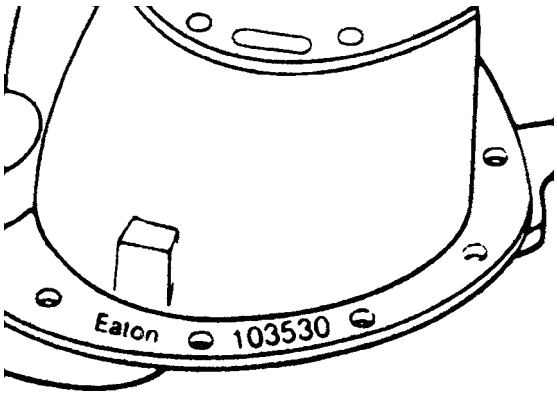
Carrier Design and Identification

(DT440-P, DT460-P, DT480-P and DP440-P through DP650-P)
On August 1, 1981, these axles were converted to a new configuration which includes redesign of the axle differential carrier; input shaft bearing, involute side gear and axle shaft spline configuration. For carrier identification, see illustrations:

Axles built after August 1, 1981 with Carrier Casting No. 110500



Axles built before August 1, 1981 with Carrier Casting No. 103530



Note: Refer to Dana Parts Book AXIP-0108 for parts information.

Input Shaft
Input shaft with Carrier Casting 110500 is equipped with a tapered roller bearing. Casting 103530 uses a ball bearing.

Input Shaft Bearing Spacer
Used only with Carrier Casting 110500.

Pinion Bearing Sleeve
Used only with Carrier Casting 103530.

Pinion Helical Gear Spacer
Used only on DT/DP440-P and DT/DP460-P (ratios 3.90-6.17).

Output Shaft Rear Bearing Retaining Washer
Used only on DT440-P - DT485-P and DP440-P - DP650-P.

Lube Pump Drive Shaft
The drive shaft on early pump design is equipped with a woodruff key. On late pump design, the key is eliminated. The drive shaft end has two machined flats and the drive gear mounting hole is shaped to accommodate these flats.

Model Listing

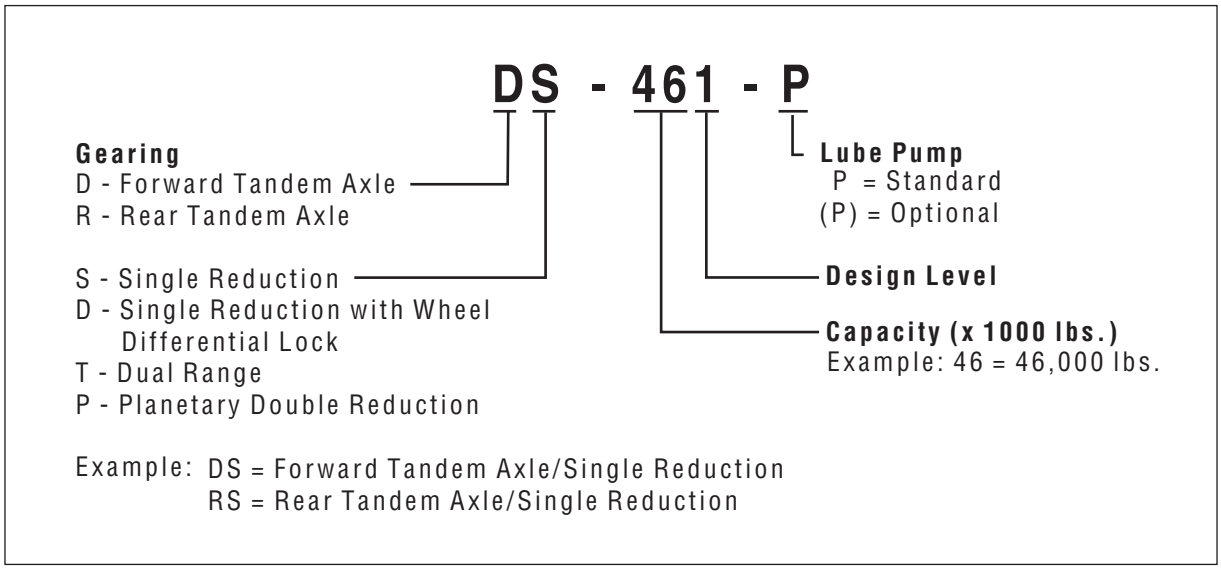
The following models are included in this publication:

Forward Axle	Rear Axle	Load Capacity
DP440-P		44,000 lbs.
DS440-P	RS440	
DT440-P		
DP460-P		46,000 lbs.
DS460-P	RS460	
DT460-P		
DD461-P	RD461	
DP461-P		
DS461-P	RS461	
DT461-P		
DP480-P		48,000 lbs.
DS480-P	RS480	
DT480-P		
DP485-P		
DT485-P		
DD521-P	RD521	52,000 lbs.
DP521-P		
DS521-P	RS521	
DT521-P		
DP580-P		58,000 lbs.
DD581-P	RD581	
DS581-P	RS581	
DP581-P		
DP601-P		60,000 lbs
DT601-P		
DP650-P		65,000 lbs
DP651-P		
DT461-P		
DP652-P		

The suffix letter "P" in the model number indicates the axle is equipped with a lube pump which provides positive lubrication in the inter-axle differential and other power divider parts.

Model variations and parts identification information is included throughout this manual. For more detailed parts information, refer to your Dana parts books.

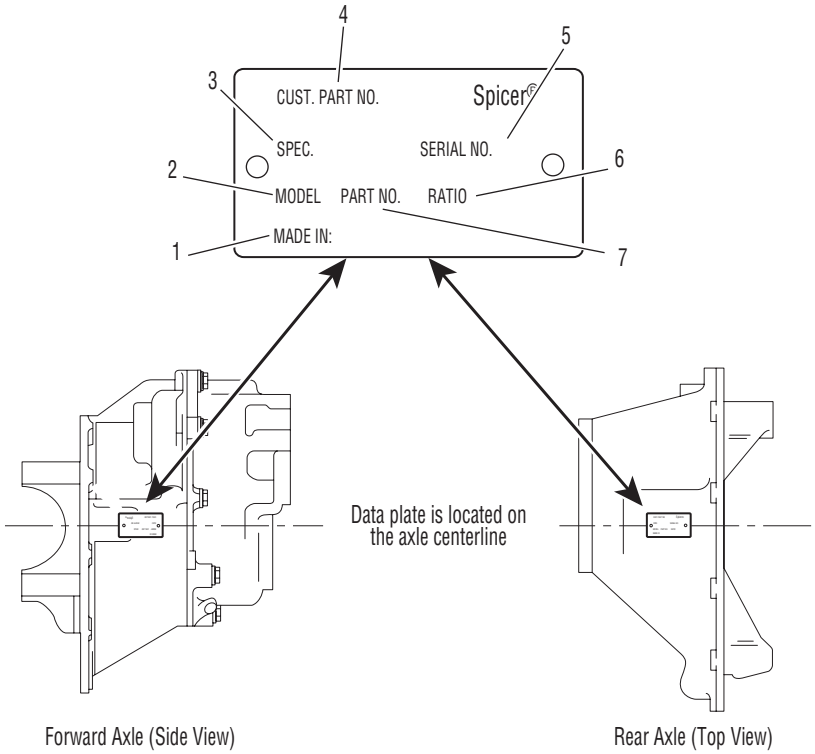
Model Information



Model Identification

Drive Axle

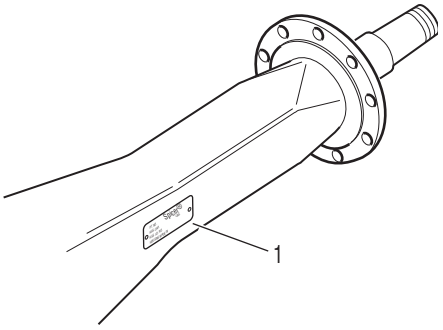
Note: Tags that do not include all the information shown here are older models (before May 1987).



1 - Country or origin
2 - Axle model identification
3 - Specification number assigned to the axle built by Spicer. Identifies all component parts of the axle including special OEM requirements such as yokes or flanges.
4 - OEM part number assigned to the axle build
5 - Carrier assembly serial number assigned by the manufacturing plant
6 - Axle gear ratio
7 - Carrier assembly production or service part number

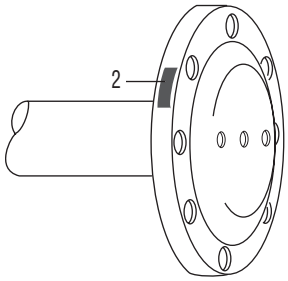
Part Identification

Axle Housing



1 - ID Tag

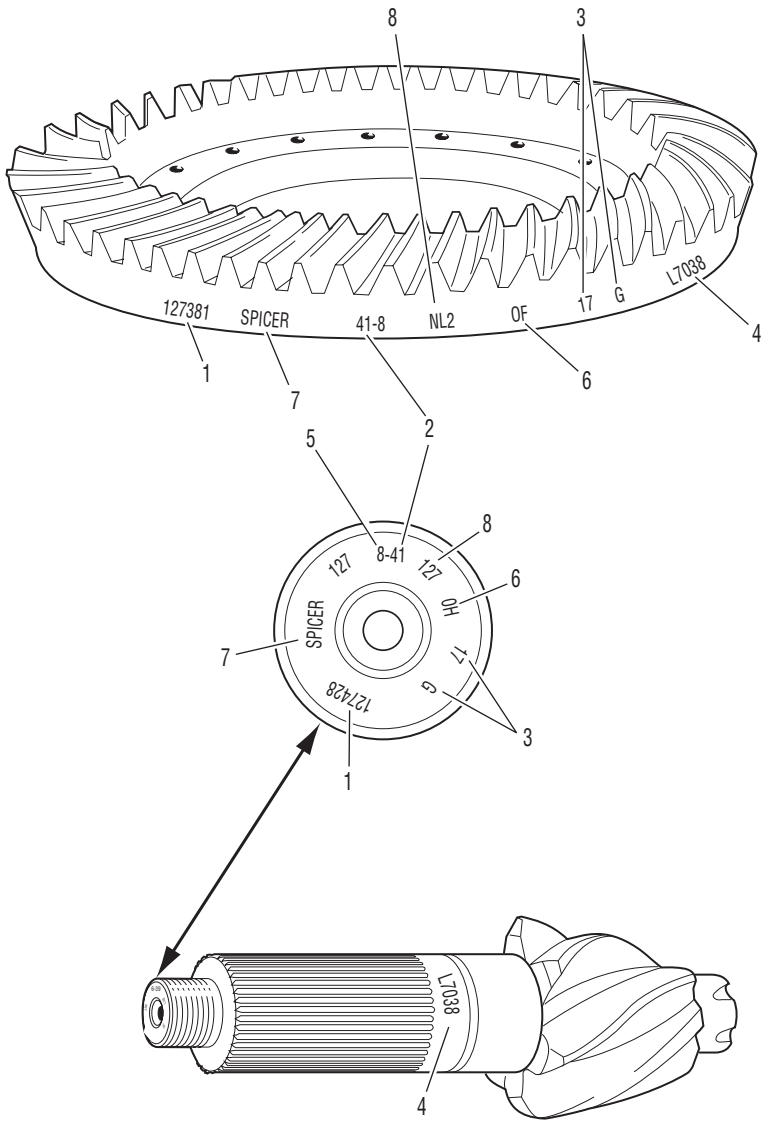
Axle Shaft



2 - Axle shaft part number

Ring Gear and Pinion

Note: Ring gear and drive pinion are matched parts and must be replaced in sets.



1 - Part number
2 - Number of ring gear teeth
3 - Manufacturing numbers
4 - Matching gear set number
5 - Number of pinion teeth
6 - Date code
7 - Indicates genuine Spicer parts
8 - Heat code

Failure Analysis

Failure analysis is the process of determining the original cause of a component failure in order to keep it from happening again. Too often, when a failed component is replaced without determining its cause, there will be a recurring failure. If a carrier housing is opened, revealing a ring gear with a broken tooth, it is not enough to settle on the broken tooth as the cause of the carrier failure. Other parts of the carrier must be examined. For a thorough understanding of the failure and possible insight into related problems, the technician needs to observe the overall condition of the vehicle.

No one benefits when a failed component goes on the junk pile with the cause unknown. Nothing is more disturbing to a customer than a repeat failure. Systematically analyzing a failure to prevent a repeat occurrence assures quality service by avoiding unnecessary downtime and further expense to the customer.

The true cause of a failure can be better determined by knowing what to look for, determining how a piece of the equipment was running and learning about previous problems. In the case of a rebuilt rear axle, mismatched gears may have been installed. The more successful shops prevent repeat equipment failures by developing good failure analysis practices. Knowing how to diagnose the cause of a premature failure is one of the prerequisites of a good heavy-equipment technician.

How to Diagnose a Failure

The following five steps are an effective approach to good failure diagnostics.

1. Document the problem.
2. Make a preliminary investigation.
3. Prepare the parts for inspection.
4. Find the cause of the failure.
5. Correct the cause of the problem.

Document the Problem

Here are some guidelines for starting to learn about a failure, including questions to ask:

- Talk to the operator of the truck.
- Look at the service records.
- Find out when the truck was last serviced.
- Ask: In what type of service is the truck being used?
- Ask: Has this particular failure occurred before?
- Ask: How was the truck working prior to the failure?

You need to be a good listener. Sometimes, insignificant or unrelated symptoms can point to the cause of the failure.

- Ask: Was the vehicle operating at normal temperatures?
- Ask: Were the gauges showing normal ranges of operation?
- Ask: Was there any unusual noise or vibration?

After listening, review the previous repair and maintenance records. If there is more than one driver, talk to all of them and compare their observations for consistency with the service and maintenance records. Verify the chassis Vehicle Identification Number (VIN) number from the vehicle identification plate, as well as the mileage and hours on the vehicle.

Make a Preliminary Investigation

These steps consist of external inspections and observations that will be valuable when combined with the results of the parts examination.

- Look for leaks, cracks or other damage that can point to the cause of the failure.
- Make note of obvious leaks around plugs and seals. A missing fill or drain plug would be an obvious cause for concern.
- Look for cracks in the carrier housing (harder to see, but sometimes visible).
- Does the general mechanical condition of the vehicle indicate proper maintenance or are there signs of neglect?
- Are the tires in good condition and do the sizes match?
- If equipped with a torque-limiting device, is it working properly?

During the preliminary investigation, write down anything out of the ordinary for later reference. Items that appear insignificant now may take on more importance when the subassemblies are torn down.

Prepare the Parts for Inspection

After the preliminary investigation, locate the failure and prepare the part for examination. In carrier failure analysis, it may be necessary to disassemble the unit.

- When disassembling subassemblies and parts, do not clean the parts immediately since cleaning may destroy some of the evidence.
- When tearing down the drive axle, do it in the recommended manner. Minimize any further damage to the unit.
- Ask more questions when examining the interior of the carrier. Does the lubricant meet the manufacturer specifications regarding quality, quantity and viscosity? As soon as you have located the failed part, take time to analyze the data.

Find the Cause of the Failure

Here begins the real challenge to determine the exact cause of the failure. Keep in mind that there is no benefit to replacing a failed part without determining the cause of the failure. For example, after examining a failed part and finding that the failure is caused by a lack of lubrication, you must determine if there was an external leak. Obviously, if there is an external leak, just replacing the failed gear is not going to correct the situation.

Another important consideration here is to determine the specific type of failure which can be a valuable indicator for the cause of failure. The following pages show different types of failures and possible causes. Use this as a guide in determining types of failures and in correcting problems.

Correct the Cause of the Problem

Once the cause of the problem has been determined, refer to the appropriate service manual to perform the repairs.

Inspection

Clean

1. Wash steel parts with ground or polished surfaces in solvent. There are many suitable commercial solvents available. Kerosene and diesel fuel are acceptable.

⚠ WARNING

Gasoline is not an acceptable solvent because of its extreme combustibility. It is unsafe in the workshop environment.

2. Wash castings or other rough parts in solvent or clean in hot solution tanks using mild alkali solutions.

Note: If a hot solution tank is used, make sure parts are heated thoroughly before rinsing.

3. Rinse thoroughly to remove all traces of the cleaning solution.
4. Dry parts immediately with clean rags.
5. Oil parts.
   - If parts are to be reused immediately: Lightly oil.
   - If parts are to be stored: Coat with oil, wrap in corrosion resistant paper and store in a clean, dry place.

Inspect Axle Housing

Axle housing inspection and repairs are limited to the following checks or repairs:

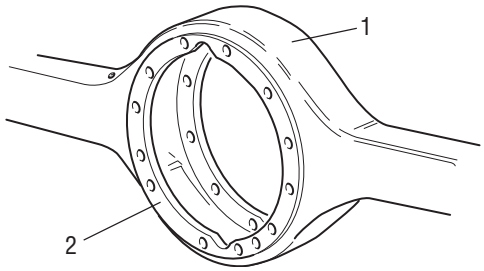
- Visually inspect axle housing for cracks, nicks and burrs on machined surfaces.
- Check carrier bolt holes and studs for foreign material.
- Replace damaged fasteners. Look for loose studs or cross threaded holes.

⚠ CAUTION

Any damage which affects the alignment or structural integrity of the housing requires housing replacement. Do not repair by bending or straightening . This process can affect the material's properties and cause it to fail completely under load.

- Check all seals and gaskets.

Note: Replace conventional gaskets with silicone rubber gasket compound (included in many repair kits). The compound provides a more effective seal against lube seepage and is easier to remove from mating surfaces when replacing parts.



1 - Axle housing
2 - Machined surface

Inspect Components

Inspect all steel parts for:

- Notches, visible steps or grooves created by wear
- Pitting or cracking along gear contact lines
- Scuffing, deformation or discolorations. These are signs of excessive heat in the axle and are usually related to low lubrication levels or improper lubrication practices.

In addition, inspect the following for damage:

- Differential gearing
- Bearings for loose fit on drive pinion, pilot bearing, and differential bearings
- All fasteners for rounded heads, bends, cracks or damaged threads.
- Inspect machined surfaces of cast or malleable parts. They must be free of nicks, burrs, cracks, scoring, and wear.
- Look for elongation of drilled holes, wear on surfaces machined for bearing fits and nicks or burrs in mating surfaces.

Inspect Primary Gearing

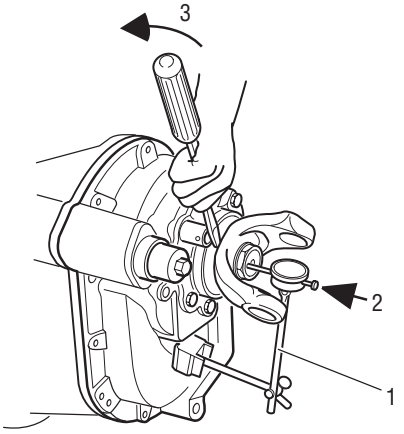
Before reusing a primary gear set, inspect teeth for signs of excessive wear. Check tooth contact pattern for evidence of incorrect adjustment.

Check Input Shaft End-play (Forward Axle)

Note: Before disassembling the power divider, measure and record input shaft end-play.

See illustration for steps 1-3.

1. Position dial indicator at yoke end of input shaft.
2. Push in on input shaft and zero the dial indicator.
3. Using a pry bar, move input shaft axially and measure/record end-play.



Adjustment
Correct end-play for a new assembly is .003" to .007". The maximum end-play for a used assembly is no more than .014". If end-play is incorrect, determine shim pack changes as follows:

Add shims to increase end-play

Desired end-play (New Parts)	0.003" to 0.007"
Measured end-play (Step 3)	0.001”-0.001”
Add shims to provide desired end-play	0.002" to 0.006"

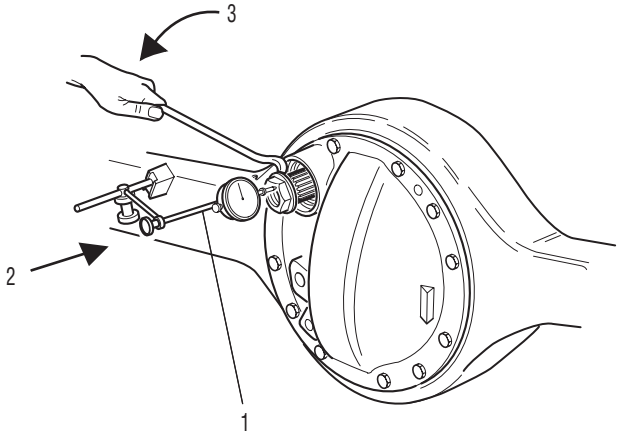
Remove shim to decrease end-play

Measured end-play (Step 3)	0.015" – 0.015"
Desired end-play (New Parts)	0.003” to 0.007”
Remove shims to provide desired end-play	0.012” to 0.008”

Check Output Shaft End-play (Forward Axle)

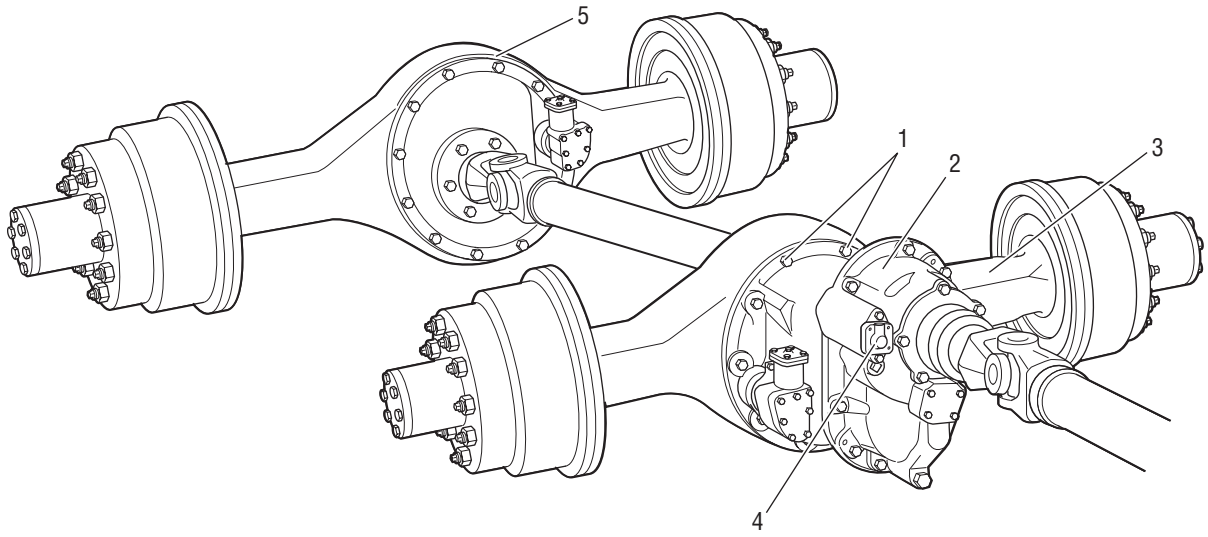
See illustration for steps 1-3.

1. Position dial indicator at yoke end of output shaft.
2. Push in on output shaft and zero the dial indicator.
3. Using a pry bar, move input shaft axially and measure/record end-play.



Adjustment
Correct end-play for a new assembly is .001" to .005". The maximum end-play for a used assembly is no more than .005". If end-play is incorrect, contact Dana.

Differential Carrier Assembly - Parts



1 - Carrier fasteners
2 - Carrier assembly
3 - Forward axle assembly
4 - Inter-axle differential lockout
5 - Rear axle assembly

Forward Axle Differential Carrier Removal and Installation

Removal of Forward Differential Carrier

Note: The removal of the forward carrier requires disconnecting of the inter-axle driveline and removal of the output shaft yoke assembly.

1. Block the vehicle.
2. Drain axle lubricant.
3. Disconnect all air lines to the axle.
4. Disconnect inter-axle and main drivelines.
5. Remove axle stud nuts and axle shafts (If used, remove lock washers and taper dowels).

⚠ WARNING

The differential lock 461/521/581 models use axle shafts with different spline length (4" or 11"). Axle shafts may also be location specific with various wheel equipment. Do not misplace axle shafts from their intended location.

TIP: To loosen dowels, hold a brass drift in the center of the shaft head and strike drift with a sharp blow using a hammer.

Do not lie under carrier after fasteners are removed. Use transmission jack to support differential carrier assembly prior to loosening fasteners.

⚠ CAUTION

Do not strike the shaft head with a steel hammer. Do not use chisels or wedges to loosen shaft or dowels.

6. Remove carrier capscrews, nuts and lock washers.
7. **Forward Models Only:** Remove output shaft shoulder nut and yoke.
8. Remove differential carrier assembly.

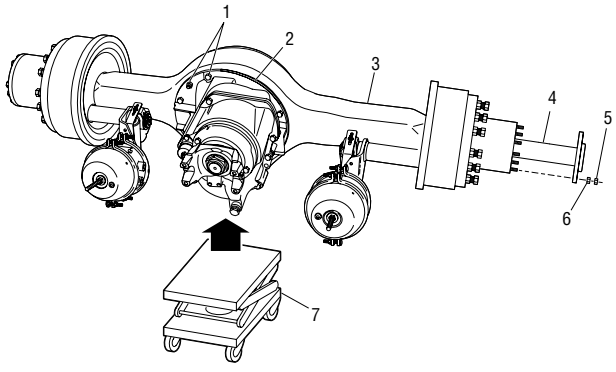
Removal of Forward Axle Housing Cover

Tip: The bearing parts can be serviced separately without removing the housing cover form the axle housing

1. Block the vehicle.
2. Drain axle lubricant.
3. Disconnect inter-axle driveline.
4. Remove output shaft shoulder nut and yoke.
5. Remove capscrews, nuts, and lock washers fastening cover to axle housing.
6. Remove oil seal and discard.
7. Remove bearing retaining washer, if used.
8. If replacement is necessary, remove snap ring, bearing and bearing sleeve.

⚠ WARNING

Snap ring is spring steel and may pop off. Wear safety glasses when removing.



1 - Carrier fasteners
2 - Carrier assembly
3 - Forward axle assembly
4 - Axle shaft
5 - Nut
6 - Lock washer
7 - Lift and support

Installation of Forward Differential Carrier

⚠ IMPORTANT

Before installing carrier assembly, inspect and thoroughly clean interior of axle housing using an appropriate solvent and clean rag.

1. Use silicone rubber gasket compound on axle housing mating surface as shown in the illustration. Completely remove all old gasket material prior to applying new material. Compound will set in 20 minutes. Install carrier before compound sets or reapply.

   TIP: To assist in installing complete differential carrier, use two pieces of threaded rod (5/8"- 11 UNS) threaded into carrier capscrew holes. Rod should be approximately 6" long. Use these to pilot the carrier into the housing.

2. Install differential carrier assembly to axle housing using lockwashers, capscrews and nuts. Torque to proper specification (see Torque Chart on page 107).
3. With the forward axle now assembled to the housing, proceed with Installation of Forward Axle Housing Cover and Output Shaft Bearing Parts, on next page.
4. Install output yoke and self-locking nut. Tighten to specified torque (see Torque Chart on page 107). Reference Yoke Installation Section page 92.
5. Install axle shafts and axle stud nuts (If used, also install lock washers and taper dowels).

⚠ WARNING

The differential lock 461/521/581 models use axle shafts with different spline length (4" or 11"). Axle shafts may also be location specific with various wheel equipment. Do not misplace axle shafts from their intended location.

6. Connect main and inter-axle driveline. Ensure drivelines are properly phased. Lubricate U-joints.
7. Add axle lubricant. See Lube Fill Capacities on page 104 for correct amount.

Note: Oil fill plug removed from D461/462/463 Differential Carriers. The oil fill plug hole located in the differential carrier was removed. Lube capacity is not affected, customers to fill axle with lube through rear cover fill hole or through the breather hole in housing. February 1, 2000.

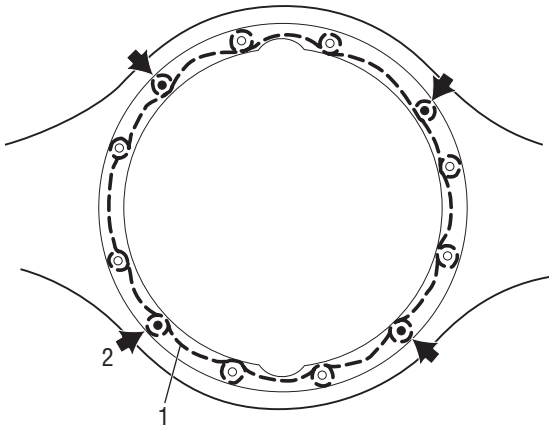
8. Connect air lines to differential.

⚠ IMPORTANT

When axle has been disassembled or housing, axle shafts or wheel equipment replaced, check axle assembly for proper differential action before operating vehicle. Wheels must rotate freely and independently.

Road test vehicle to bring axle lubricant up to temperature. Recheck joints, drain and fill plugs for leakage. Re-tighten as necessary.

Differential Carrier Side of Axle Housing



Axle Housing Silicone Gasket Compound Pattern

1 - Apply silicone gasket in this pattern
2 - Typical stud locations

Installation of Forward Axle Housing Cover and Output Shaft Bearing Parts

Note: Forward axle should be assembled to the axle housing before proceeding with the following procedure.

1. If removed, install housing cover and fasten with nuts, capscrews and lock washers. Tighten to proper torque specifications (see Torque Chart on page 107).

Note: Use silicone rubber gasket compound on axle housing mating surface as shown in illustration. Completely remove all old gasket material prior to applying new material. Compound will set in 20 minutes. Install axle housing cover and output shaft assembly before compound sets or reapply.

2. Install output shaft rear bearing. Tap the outer race (with a sleeve or brass drift) until it is seated firmly in the machined pocket of the cover. Secure with snap ring.
3. Lubricate and install the rear bearing sleeve on the output shaft. Make certain it fits snugly against the shoulder at the forward edge of the shaft splines.
4. Install the output shaft seal in the axle housing cover.

Note: Some axles require the use of a rear bearing retaining washer. Install the washer over the splines of the output shaft flush against the output shaft bearing.

5. Install output yoke and self-locking nut. Tighten to specified torque (see Torque Chart on page 107). Reference Yoke Installation Section page 92.
6. Install axle shafts and axle stud nuts (If used, also install lock washers and taper dowels).

⚠ WARNING

The differential lock 461/521/581 models use axle shafts with different spline length (4" or 11"). Axle shafts may also be location specific with various wheel equipment. Do not misplace axle shafts from their intended location.

7. Connect main and inter-axle driveline. Ensure drivelines are properly phased. Lubricate U-joints.
8. Add axle lubricant. See Lube Fill Capactities on page 104 for correct amount.

Note: Oil fill plug removed from D461/462/463 Differential Carriers. The oil fill plug hole located in the differential carrier was removed. Lube capacity is not affected, customers to fill axle with lube through rear cover fill hole or through the breather hole in housing. February 1, 2000.

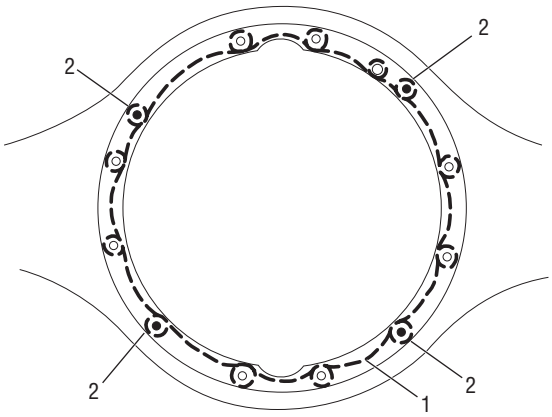
9. Connect air lines to differential.

⚠ IMPORTANT

When axle has been disassembled or housing, axle shafts or wheel equipment replaced, check axle assembly for proper differential action before operating vehicle. Wheels must rotate freely and independently.

Road test vehicle to bring axle lubricant up to temperature. Recheck joints, drain and fill plugs for leakage. Re-tighten as necessary.

Cover Side of Axle Housing



1 - Apply silicone gasket in this pattern
2 - Stud locations (varies by model)

Rear Axle Differential Carrier Removal and Installation

Removal of Rear Differential Carrier
Perform the following steps:

1. Block the vehicle.
2. Drain axle lubricant.
3. Disconnect air line if working on a differential lock axle. (See Differential Lockout Section).
4. Disconnect inter-axle driveline.
5. Remove axle stud nuts and axle shafts (If used, remove lock washers and taper dowels).

⚠ WARNING

The differential lock 461/521/581 models use axle shafts with different spline length (4" or 11"). Axle shafts may also be location specific with various wheel equipment. Do not misplace axle shafts from their intended location.

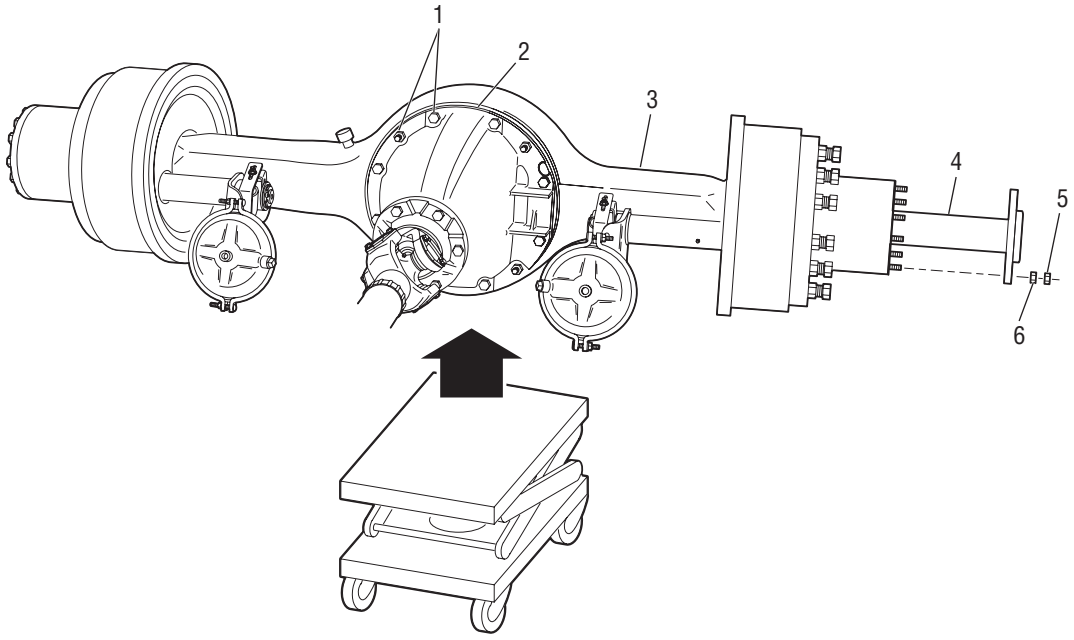
TIP: To loosen dowels, hold a brass drift in the center of the shaft head and strike drift with a sharp blow using a hammer.

Do not lie under carrier after fasteners are removed. Use transmission jack to support differential carrier assembly prior to loosening fasteners.

⚠ CAUTION

Do not strike the shaft head with a steel hammer. Do not use chisels or wedges to loosen shaft or dowels.

6. Remove capscrews, nuts and lock washers.
7. Remove differential carrier assembly.



1 - Carrier fasteners
2 - Carrier assembly
3 - Rear axle assembly
4 - Axle shaft
5 - Nut
6 - Lock washer

Rear Differential Carrier “Installation”

⚠ IMPORTANT

Before installing carrier assembly, inspect and thoroughly clean interior of axle housing using an appropriate solvent and clean rag.

Note: Apply silicone rubber gasket compound on axle housing mating surface as shown in illustration. Completely remove all old gasket material prior to applying new material. Compound will set in 20 minutes. Install carrier before compound sets or reapply.

1. Install differential carrier assembly.

   TIP: To assist in installing complete differential carrier use two pieces of threaded rod (5/8"- 11 UNS) threaded into carrier capscrew holes. Rod should be approximately 6" long. Use these to pilot the carrier into the housing.

2. Install carrier to axle housing lock washers, capscrews and nuts. Torque to proper specification. See “Torque Chart” on page 107.

3. Install axle shafts and axle stud nuts (If used, also install lock washers and taper dowels).

⚠ WARNING

The differential lock 461/521/581 models use axle shafts with different spline length (4" or 11"). Axle shafts may also be location specific with various wheel equipment. Do not misplace axle shafts from their intended location.

4. Connect inter-axle driveline, making sure driveline is in phase. Lubricate U-joints.

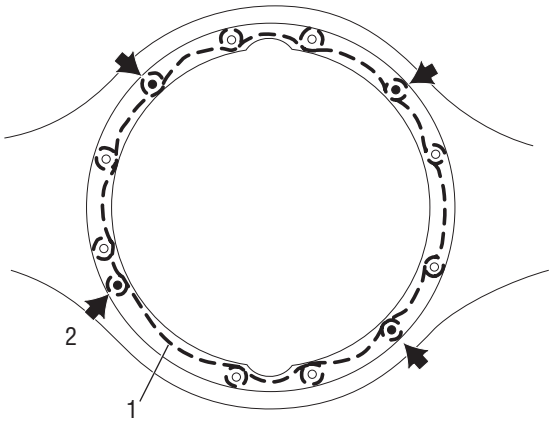
5. Add axle lubricant. Fill to bottom of filler hole. See “Change Lube” on page 104. Reference Lube Fill Capacities for correct amount.

6. Connect air line to differential if working on a differential lock model axle.

⚠ IMPORTANT

When axle has been disassembled or housing axle shafts or wheel equipment replaced, check axle assembly Afor proper differential action before operating vehicle. Wheels must rotate freely and independently.

Road test vehicle to bring axle lubricant up to temperature. Recheck joints, drain and fill plugs for leakage. Re-tighten as necessary.



1 - Apply silicone gasket in this pattern
2 - Typical stud locations

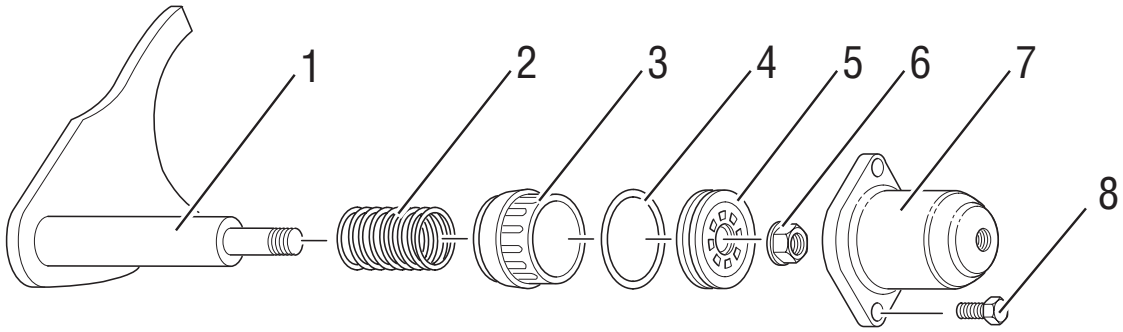
Differential Lockout

Inter-Axle Lockout Types

All are air-operated to engage the lockout and spring-released to disengage the lockout with the exception of the “Reverse-Air” lockout. The “Reverse-Air” lockout is spring-released to engage the lockout and air-operated to disengage the lockout.

Cast Iron Cover Lockout - February 1996 to Present (Single Reduction Models)

- External type lockout
- Cast iron piston cover

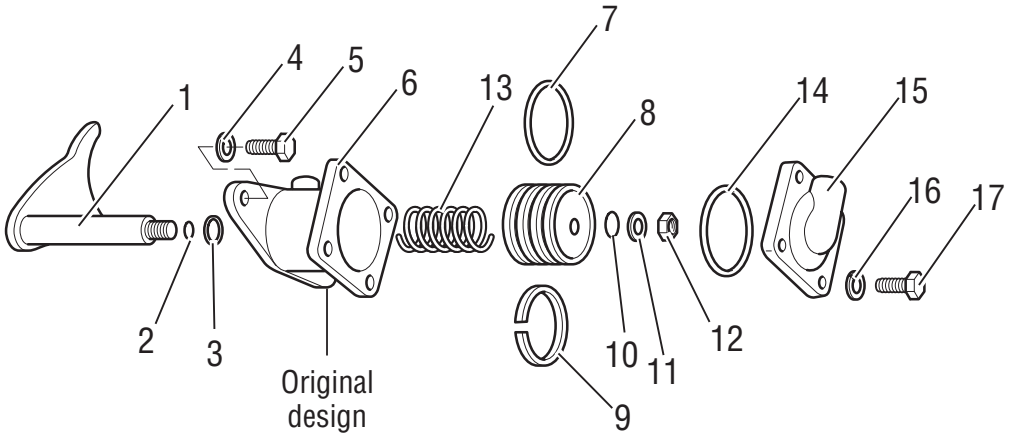


1 - Shift fork assembly
2 - Compression spring
3 - Piston driver
4 - O-ring
5 - Piston
6 - Lock nut
7 - Cast iron piston housing
8 - Capscrew

Original Design Lockout - 1948 to Present (*Optional design for use with all dual range tandem axles)

- Die cast body
- Square Top
- Interchangeable with cast iron lockout*

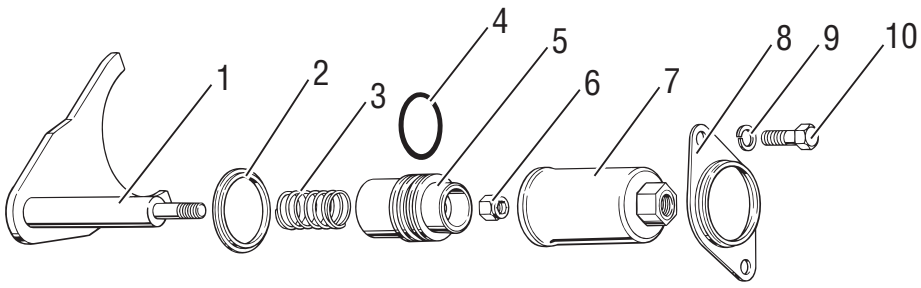
"In 1985, a "Protective Shift System" was released into production axles. Dana bulletin 85-03 explains this popular OEM option. This option can only work with the "original" design lockouts.



1 - Shift fork assembly
2 - Push rod o-ring
3 - Body o-ring
4 - Lock washer
5 - Cap screw
6 - Original design lockout body
7 - Piston o-ring
8 - Piston
9 - Felt oilers
10 - O-ring
11 - Flat washer
12 - Lock nut
13 - Compression spring
14 - Cover o-ring
15 - Cover
16 - Lock washer
17 - Capscrew

Cylindrical Design Lockout - October 1989 to February 1996

- External type lockout
- Stamped steel piston cover
- Interchangeable with the cast style cover only as a complete assembly



1 - Shift fork assembly
2 - Shoulder washer
3 - Compression spring
4 - O-ring
5 - Piston
6 - Lock nut
7 - Cylindrical design piston housing
8 - Mounting bracket
9 - Lock washer
10 - Capscrew

Differential Lockout Overhaul

Instructions for the three different designs are on the following pages:

Cast Iron Cover Lockout - Overhaul on page 20

Original Design Lockout - Overhaul on page 21

Cylindrical Design Lockout - Overhaul on page 22

Cast Iron Cover Lockout - Overhaul

Disassemble and Remove Lockout

Note: With axle installed in vehicle, place differential lock selector valve in the disengaged (or unlocked) position. Disconnect the air line at the lockout piston cover.

1. Remove capscrews and lock washers fastening piston housing to power divider cover. Remove the cast iron piston housing.
2. Remove lock nut, piston with o-ring, piston driver and compression spring from push rod.

Note: The shift fork and push rod cannot be removed with power divider cover installed (see Remove Power Divider on page 24).

Lockout Interchangeability

The cast iron design lockout assembly is interchangeable with previously designed lockouts, only as a complete assembly. The original shift fork and push rod can be used for all three design type lockouts and need not be replaced.

Retrofit kits are available to convert the non-current design lockouts to the current cast iron cover design lockout. For additional information, refer to Dana Parts Books AXIP-0085.

Retrofit as follows:

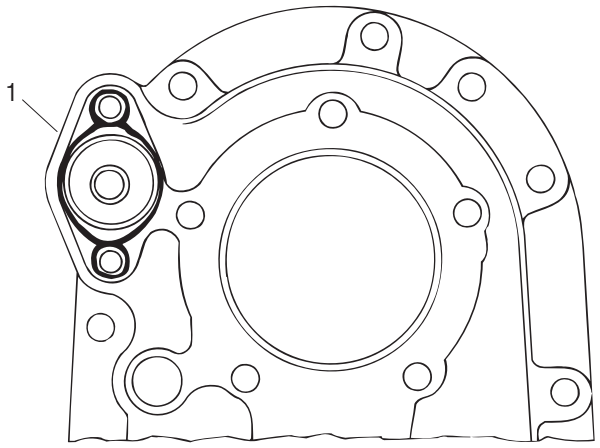
1. Disassemble and remove the old design lockout.
2. Assemble and install the cast iron cover lock-out.

⚠ CAUTION

Mounting screws are not interchangeable between the various design style lockouts. They are a different length and size.

Assemble and Install Lockout - Cast Iron Cover Design

1. With shift fork and sliding clutch installed, install compression spring on push rod.
2. Place piston driver on push rod against compression spring. The large diameter end of piston driver must face power divider cover.
3. Lubricate o-ring with silicone-based lubricant and install o-ring on piston.
4. Place piston assembly on push rod against piston driver.
5. Install lock nut on push rod and tighten to 13-17 lbs. ft. (18-23 N•m).
6. Apply silicone gasket compound to mounting surface on power divider cover.



1 - Lockout silicone gasket pattern

7. Install piston housing cover.
8. Install capscrews and tighten to 48-56 lbs. ft. (65-76 N•m).
9. If axle is installed in vehicle, apply sealant to air line fitting and connect air line.

Original Design Lockout Overhaul

Note: Find instructions for:

Cast Iron Cover Lockout - Overhaul on page 20
Cylindrical Design Lockout - Overhaul on page 22

Disassemble and Remove Lockout

Note: With axle installed in vehicle, place differential lock selector valve in the disengaged (or unlocked) position. Disconnect the air line at the lockout piston cover.

1. Remove capscrews and lock washers fastening cover to the body. Remove cover and o-ring.
2. Remove nut, flat washer and o-ring from push rod.
3. Remove body capscrews and lock washers, then remove body and piston as an assembly. Remove o-ring and felt oilers from the piston.

Note: The shift fork and push rod cannot be removed with power divider cover installed (see Remove Power Divider on page 24).

Retrofit Original Design to Cast Iron Cover Design Lockout

The cast iron cover design lockout assembly is interchangeable with the original design lockout, only as a complete assembly. The original shift fork and push rod can be used for either model lockout and need not be replaced.

Retrofit kits are available to convert the non-current design lockouts to the current cast iron cover design lockout. For additional information, refer to Dana Parts Books AXIP-0085.

Retrofit as follows:

1. Disassemble and remove the original design lockout.
2. Assemble and install the cast iron cover lockout.

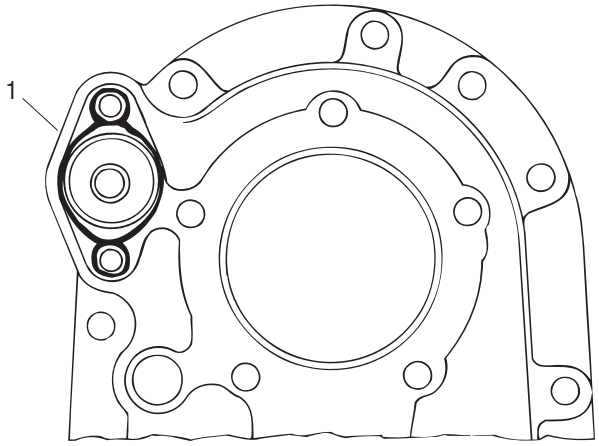
⚠ CAUTION

Mounting screws are not interchangeable between the various design style lockouts. They are a different length and size.

Assemble and Install Original Design Lockout

With shift fork and sliding clutch installed in power divider cover, assemble and install lockout as follows:

1. Apply silicone gasket compound to mounting surface on power divider cover.



1 - Lockout silicone gasket pattern

2. Install lockout body. Secure with capscrews and lock washers. Torque capscrews to 48-56 lbs. ft. (65-76 N•m).

Note: Before installation, soak piston felt oilers in SAE 30 engine oil and lubricate o-rings with a high-viscosity silicone oil or barium grease o-ring lubricant.

3. Install felt oilers and large o-ring on piston.
4. Install compression spring over shift fork push rod. Install piston over end of shift fork into lockout body. Secure with lock washers and lock nut. Torque locknut (see Torque Chart on page 107).
5. Install o-ring in lockout body cover. Install cover and secure with capscrews and lock washers. Torque capscrews to 96-108 lbs. in. (10-13 N•m).

Cylindrical Design Lockout - Overhaul

Note: Find instructions for:

Cast Iron Cover Lockout - Overhaul on page 20

Original Design Lockout - Overhaul on page 21

Disassemble and Remove Lockout

Note: With axle installed in vehicle, place differential lock selector valve in the disengaged (or unlocked) position. Disconnect the air line at the lockout piston cover.

1. Remove capscrews and lock washers fastening mounting bracket to power divider cover. Remove bracket and piston housing.
2. Remove lock nut, piston with o-ring, compression spring and shoulder washer from push rod.

Note: The shift fork and push rod cannot be removed with power divider cover installed (see Remove Power Divider on page 24).

Retrofit Cylindrical Design to Cast Iron Cover Design Lockout

The cast iron cover design lockout assembly is interchangeable with the cylindrical design lockout, only as a complete assembly. The original shift fork and push rod can be used for either type lockout and need not be replaced.

Retrofit kits are available to convert the non-current design lockouts to the current cast iron cover design lockout. For additional information, refer to Dana Parts Books AXIP-0085.

Retrofit as follows:

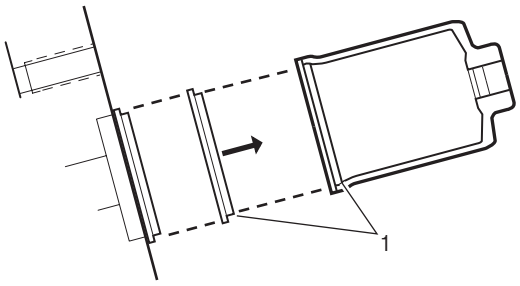
1. Disassemble and remove the cylindrical design lockout.
2. Assemble and install the cast iron cover lockout.

⚠ CAUTION

Mounting screws are not interchangeable between various design style lockouts. They are a different length and size.

Assemble and Install Lockout-Cylindrical Design

1. With shift fork and sliding clutch installed, place the shoulder washer (white plastic) over push rod. The large diameter side of the washer must face the power divider cover.
2. Install compression spring on push rod.
3. Lubricate o-ring with silicone-based lubricant and install o-ring on piston.
4. Place piston assembly on push rod. The large diameter end of piston must face power divider cover.
5. Install lock nut on push rod and tighten to 13-17 lbs. ft. (18-23 N•m).
6. Install piston housing, making sure the housing is correctly seated and piloted in the shoulder washer.

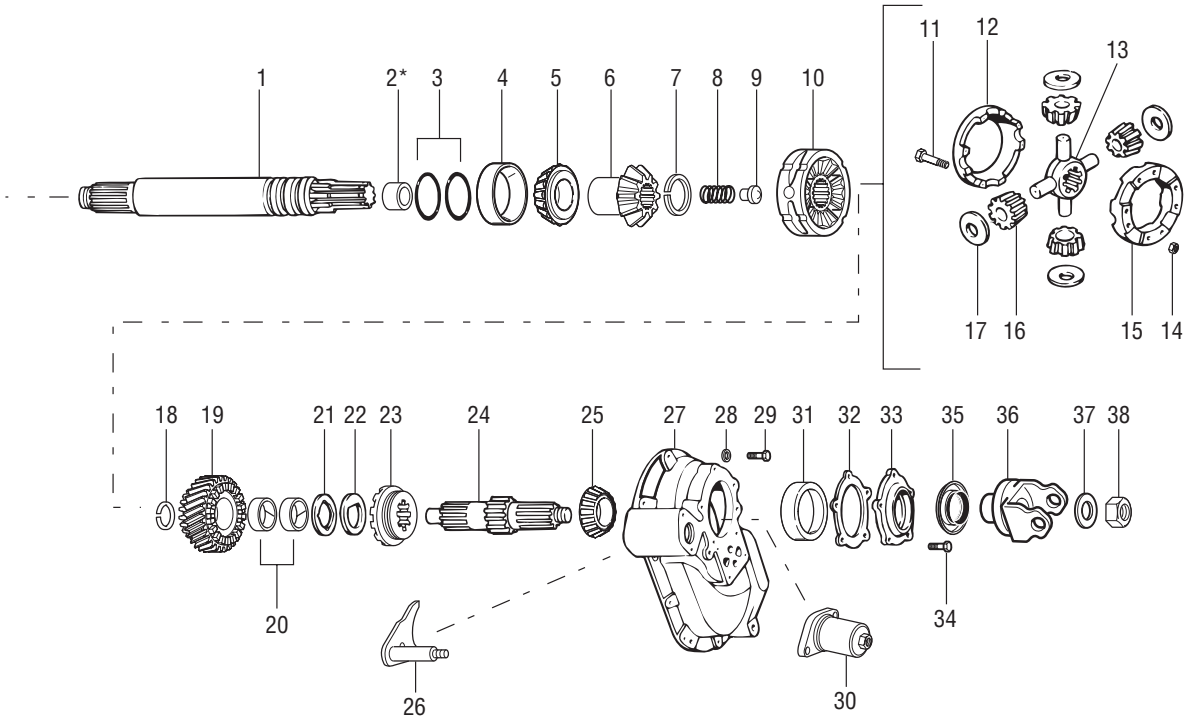


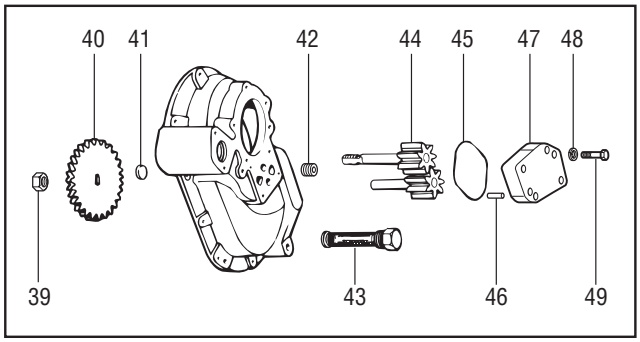
1 - Shoulder washer must seat properly

7. Place mounting bracket over housing and position on power divider cover. Install capscrews and lock washers and tighten to 48-56 lbs. ft. (65-76 N•m)

Note: If axle is installed in vehicle, apply sealant to air line fitting and connect air line. When tightening air line, hold piston housing in mounting position using a wrench applied to the hexagon configuration at outer end of housing.

Power Divider - Parts Exploded View





1 - Output shaft
2 - Bushings*
3 - O-rings
4 - Bearing cup
5 - Bearing cone
6 - Side gear
7 - Snap ring
8 - Spring
9 - Button
10 - Inter-axle differential assembly
11 - Capscrew
12 - Case half
13 - Spider
14 - Nut
* Removed in September 1994

15 - Case half
16 - Side pinion
17 - Thrust washer
18 - Snap ring
19 - Helical gear
20 - Bushings
21 - Thrust washer
22 - “D” washer
23 - Lockout sliding clutch
24 - Input shaft
25 - Bearing cone
25 - Shift fork and push rod
27 - Power divider cover
28 - Lock washer
29 - Capscrew

30 - Lockout unit
31 - Bearing cup
32 - Shim
33 - Bearing cover
34 - Capscrew
35 - Oil seal
36 - Yoke
37 - Flat washer
38 - Nut

Lube Pump Parts
39 - Lock nut
40 - Pump drive gear
41 - Expansion plug
42 - Pipe plug
43 - Magnetic screen
44 - Pump gears
45 - O-ring
46 - Dowel pin
47 - Pump cover
48 - Lock washer
49 - Capscrew

Remove Power Divider

The power divider can be replaced with the axle assembly both in or out of the chassis and with the differential carrier assembled to the axle housing.

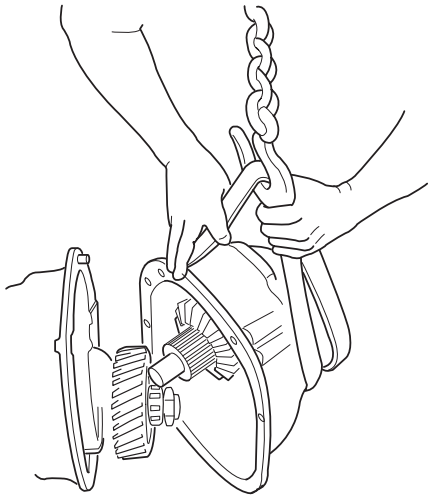
⚠ CAUTION

During removal of power divider cover, the inter-axle differential (IAD), input shaft assembly or IAD shift system parts may fall from the carrier if not careful. Use caution to prevent injury or damage.

1. Disconnect the main driveline.
2. Disconnect the lockout air line.
3. If overhauling the power divider, loosen but do not remove input nut.
4. Position a drain pan under the unit.
5. Remove PDU capscrews.

Method A - With Carrier Installed in Chassis

1. Use a transmission jack or a chain hoist and a sling.
2. Wrap sling strap around power divider and attach to chain hoist hook.



3. Tap on the sides of the cover at the dowel pins with a mallet to create a space large enough to finish freeing the cover from the dowel pins.
4. Pull the power divider forward until the input shaft stub end is free of the output side gear, then remove the assembly.
5. Remove IAD assembly.

Method B - With Carrier Out of Chassis

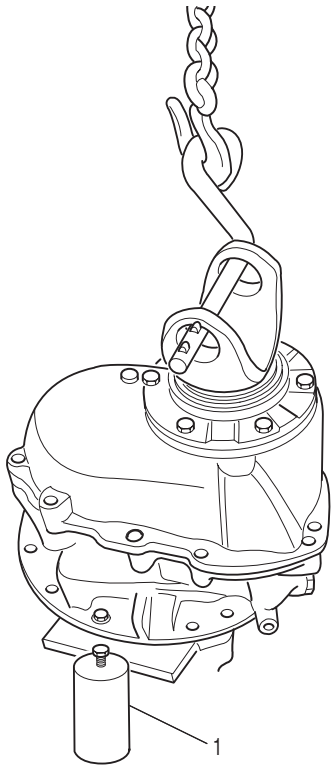
1. Use a chain hoist.
2. Mount carrier assembly in carrier assembly stand.
3. Remove PDU capscrews.
4. Fasten chain or strap to input yoke to remove power divider.

⚠ CAUTION

During removal of power divider cover, the inter-axle differential (IAD), input shaft assembly or IAD shift system parts may fall from the carrier if not careful. Use caution to prevent injury or damage.

Note: Lifting mechanism may create nicks and burrs on input yoke. Remove nicks and burrs if present.

5. Tap the sides of the cover at the dowel pin location with a mallet to loosen cover.
6. Remove PDU assembly.
7. Remove IAD assembly.



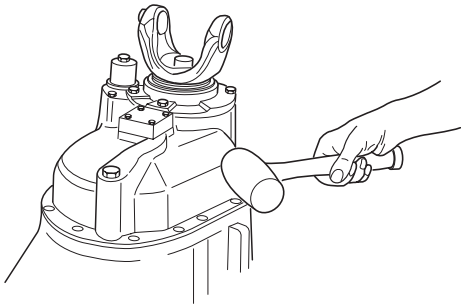
1 - Carrier assembly stand

Remove Power Divider from Differential Carrier (with carrier removed from axle housing)

Note: It is assumed that the differential carrier assembly has been removed from axle housing prior to starting the following procedures:

1. Mount differential carrier in repair stand. Loosen input shaft nut.
2. Remove power divider cover capscrews and lock washers.
3. Fasten chain or strap to input yoke to remove power divider.

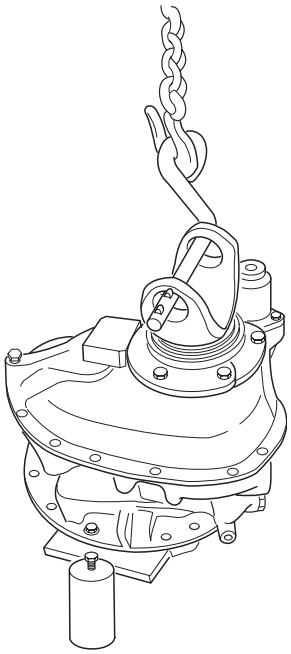
Note: Power divider may not separate easily, strike the cover near the dowel pin location with a mallet.



⚠ CAUTION

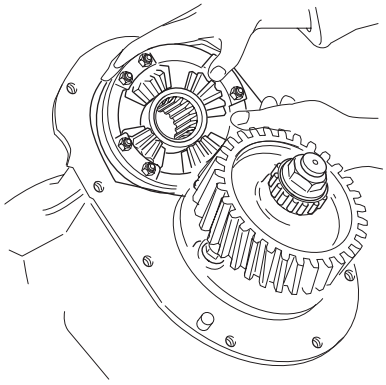
During removal of power divider, the inter-axle differential may fall off input shaft from differential carrier. Exert caution to prevent damage of injury.

4. Tap the sides of the cover at the dowel pin location with a mallet to loosen cover.
5. With chain hoist attached to input yoke, lift power divider off carrier.



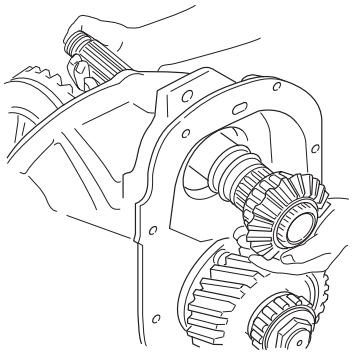
Note: Lifting mechanism may create nicks or burrs on input yoke. Remove if present.

6. Lift inter-axle differential assembly out of carrier or off of output shaft side gear.

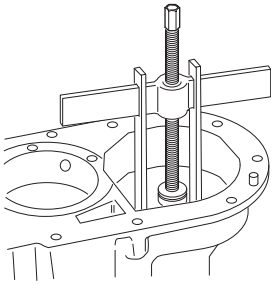


Note: Late model axles may be equipped with a spring and thrust button mounted between the input and output shafts, remove these parts.

7. Tilt carrier and remove the output shaft assembly.



8. If removal of the output shaft side gear bearing cup is necessary, use puller to remove bearing cup from carrier

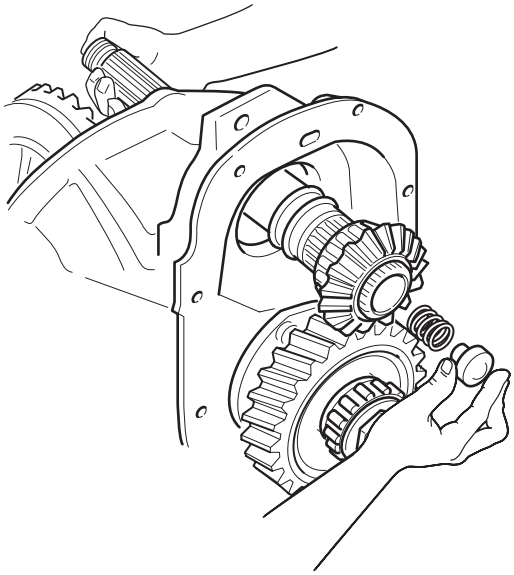


Disassemble, Assemble and Overhaul the Power Divider

The power divider may be serviced with the carrier assembly in or out of the axle housing.

Note: The following procedure assumes that the differential carrier has been removed from the axle housing and that the power divider has been removed from the carrier assembly.

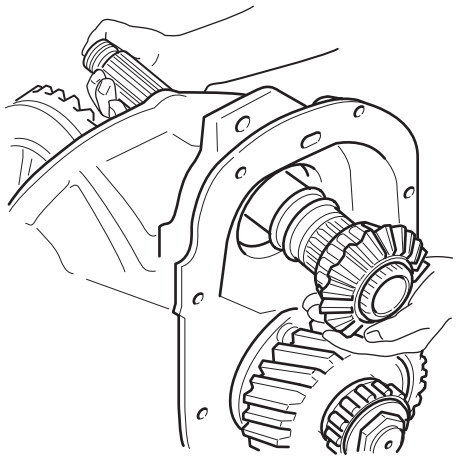
1. Late model axles may be equipped with a spring and thrust button mounted between the input and output shafts, remove these parts.
2. Remove output shaft and output side gear



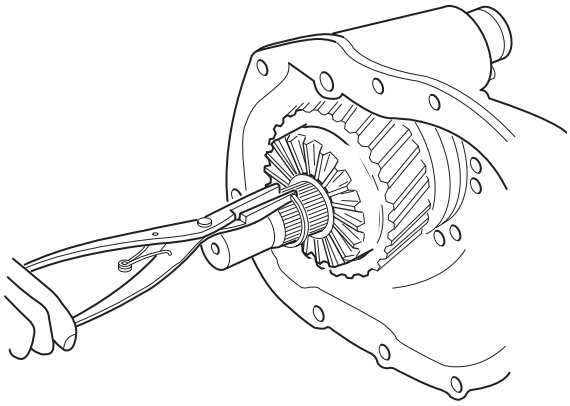
3. If replacement of the output shaft side gear bearing cup is necessary, use either of the following methods:

   Weld: Place a weld bead around the inside of the cup, when the weld cools the cup will fall out.

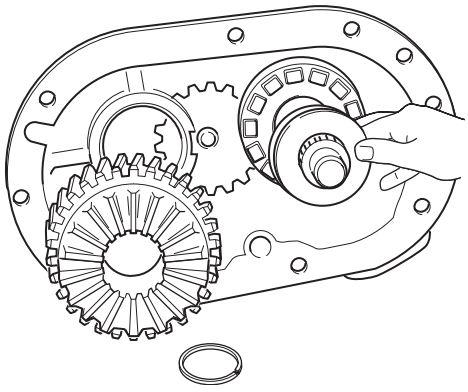
   Hammer: Use slipper to get under the cup and with a hammer and drift from the back side of carrier tap out bearing cup.



4. Remove snap ring from machined groove at rear of input shaft.



5. Slide helical side gear off input shaft.
6. Remove helical side gear thrust washer, and “D” washer from shaft.



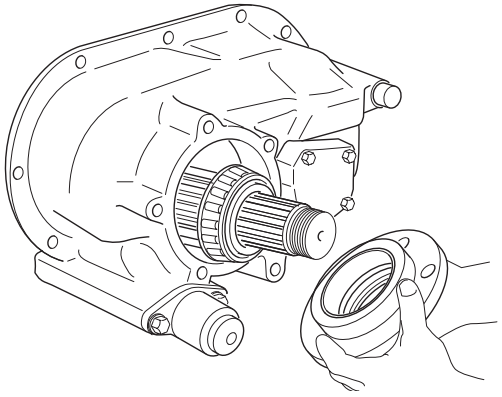
7. At this point in disassembly, it is desirable to remove lube pump drive gear nut. Hold input shaft yoke to secure drive gear, then loosen and remove drive gear nut.
8. Remove input shaft nut and flat washer.

Note: Some models do not use flat washer as it is built into the nut.

9. Remove yoke from input shaft using a puller tool.

   TIP: A yoke puller tool may be made from the center section of most gear puller tools, or may be purchased from your local tool distributor.

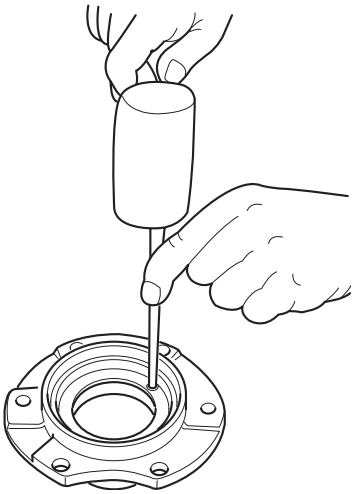
10. Remove input bearing cage, capscrews, input bearing cover and shim pack.



11. If input shaft bearing cup needs replacement, use either of the following recommended practices:

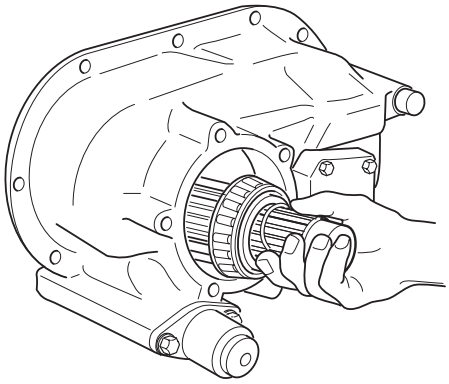
    Weld: Place a weld bead around the cup, when the weld cools the cup will fall out.

    Drill: Drill a 1/4 inch size hole through the bearing cover to the back side of the cup and use a punch to remove the bearing cup.

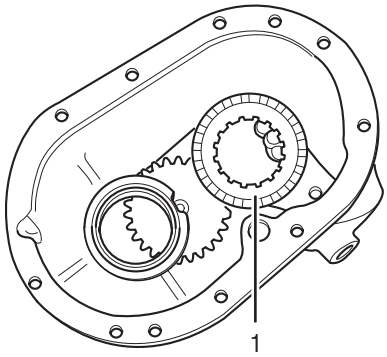


Note: Shift fork cannot be removed until lockout unit is disassembled (see Differential Lockout Overhaul on page 20). Shift fork push rod is secured to the lockout piston with a nut.

12. Slide input shaft assembly out of cover.

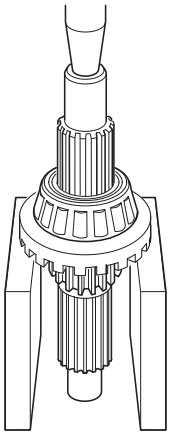


13. Remove sliding clutch.



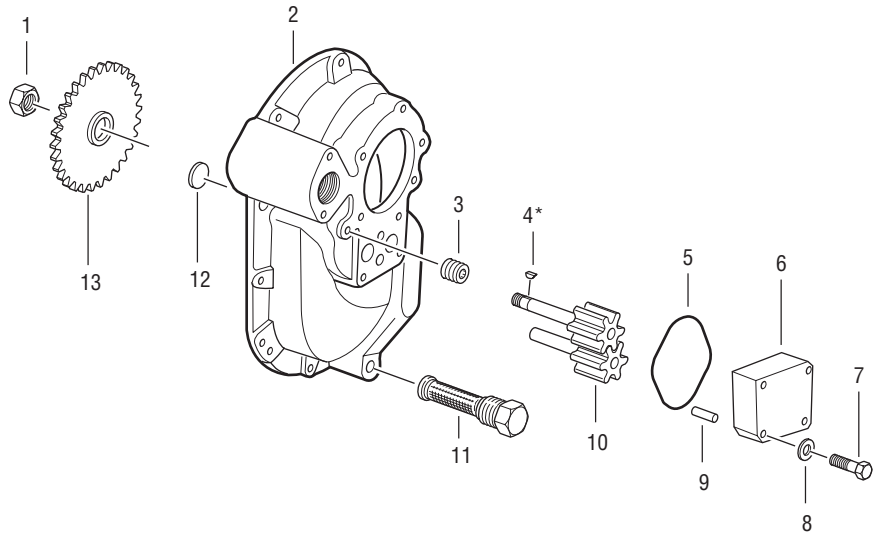
1 - Sliding clutch

14. Remove input shaft bearing cone. Temporarily place lockout sliding clutch over rear of input shaft, teeth toward bearing cone. Place shaft in press and remove.



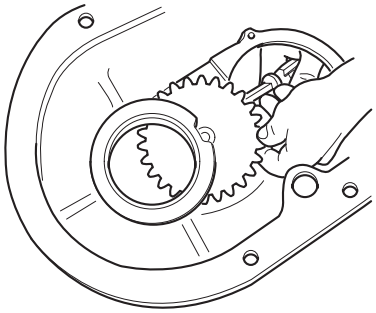
Disassemble Power Divider Cover (For Axles with Input Shaft Tapered Roller Bearing)

Note: The drive on early pump models is equipped with a woodruff key. On late pump models the key is eliminated. The drive shaft end has two machined flats and the drive gear mounting hole is shaped to accommodate these flats.



1 - Lock nut
2 - Power divider cover
3 - Pipe plug
4 - Woodruff key
5 - O-ring
6 - Pump cover
7 - Capscrew
8 - Lock washer
9 - Dowel pin
10 - Pump gears
11 - Magnetic strainer
12 - Expansion plug
13 - Pump drive gear

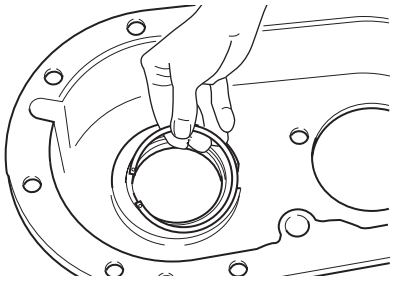
1. With drive gear locknut previously removed and working through input shaft bore, gently pry oil pump drive gear from its shaft. See steps 5 and 6 for pump disassembly.



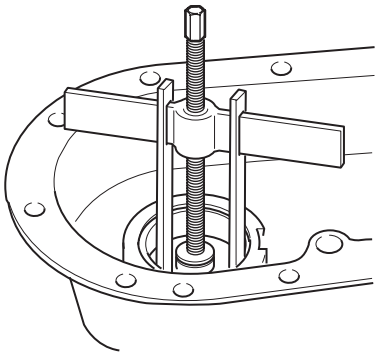
2. For models built before February 1, 2000, remove snap ring securing pinion outer support bearing race. For models built after February 1, 2000, a design change to a one piece roller bearing was implemented. Reference Dana Bulletin ABIB-0102 for more information.

⚠ WARNING

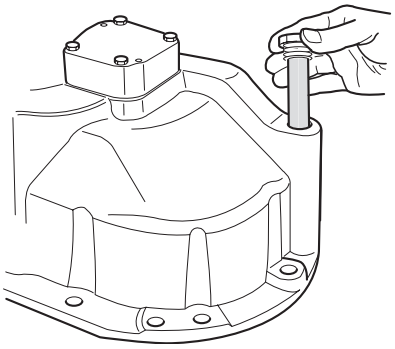
Snap ring is spring steel and may pop out. Wear safety glasses when removing.



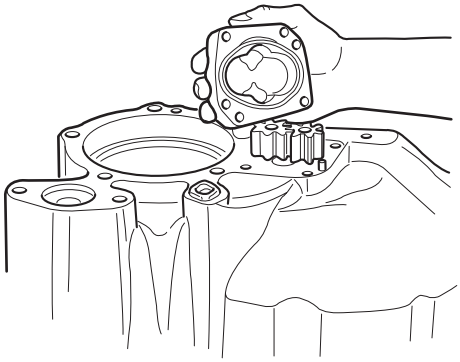
3. Remove pinion outer support bearing race with suitable puller.



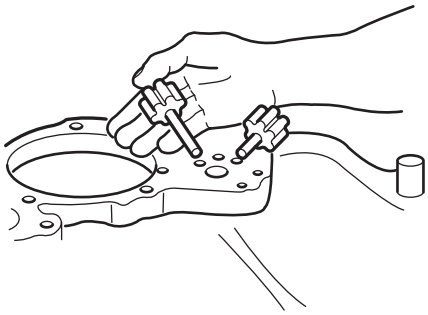
4. Unscrew and remove magnetic strainer from power divider cover.



5. Remove oil pump cover capscrews and lock washers. Remove pump cover and o-ring.

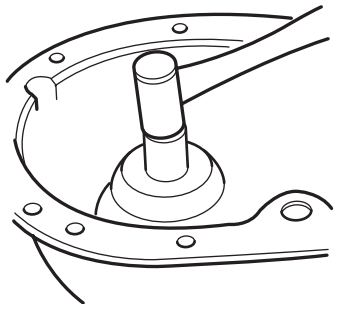


6. When woodruff key is used, remove key from gear shaft. Remove pump gears from power divider cover.



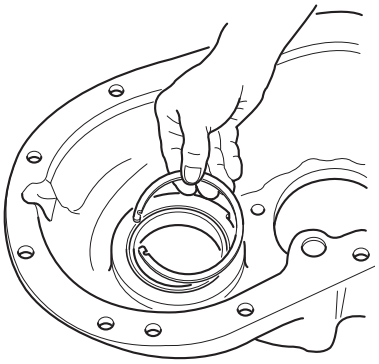
Assemble Power Divider Cover (For Axles with Input Shaft Tapered Roller Bearing)

1. Install pinion outer bearing race in power divider cover using a driver and a hammer.



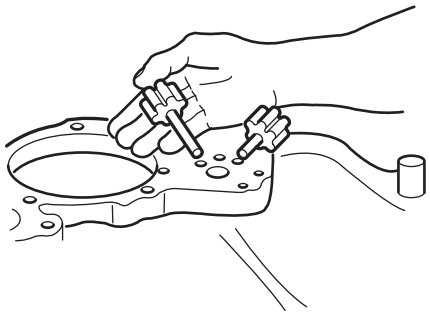
2. For models built before February 1, 2000, install snap ring to secure bearing race. For models built after February 1, 2000, a design change to a one piece roller bearing was implemented. Reference Dana Bulletin ABIB-0102 for more information.

⚠ WARNING

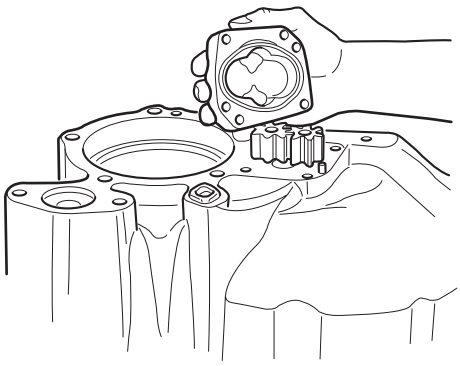


Snap ring is spring steel and may pop out. Wear safety glasses when installing.

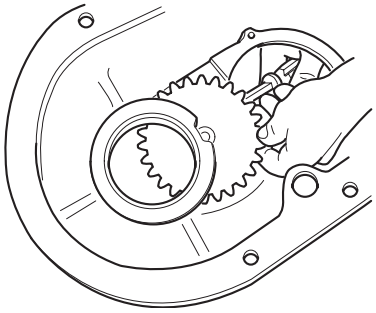
3. Install pump gears in power divider cover (position gear with long shaft in opening adjacent to input shaft).



4. Install o-ring in pump cover, making sure o-ring is seated firmly in body. If removed, install dowel pins. Install pump cover on power divider cover and secure with capscrews and lock washers. (See Torque Chart on page 107).

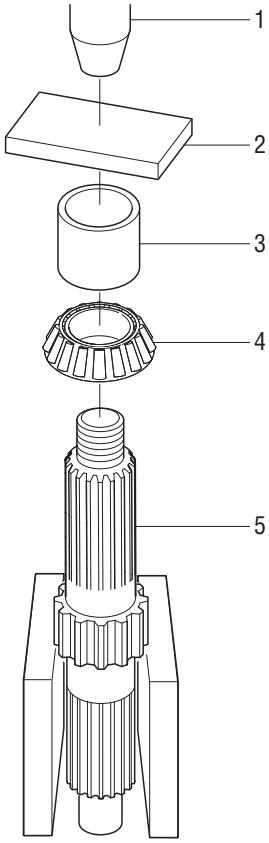


5. Install pump drive gear. Install drive gear on pump shaft end. Hand tighten drive gear nut.



Note: Some pump drive shafts use a woodruff key. When key is used, place key in shaft slot. Position gear on shaft engaging key. Then install gear with driver and hammer.

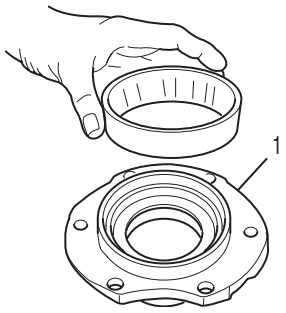
6. Press input bearing cone on input shaft.



1 - Press
2 - Plate
3 - Drive Seal
4 - Input shaft bearing cone
5 - Input shaft

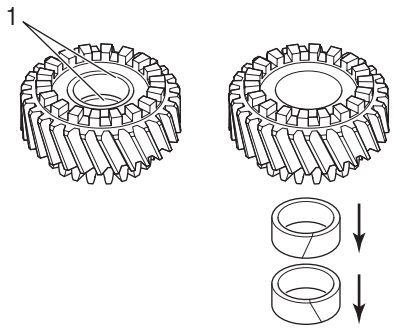
1 - Press
2 - Plate
3 - Drive sleeve
4 - Input shaft bearing cone
5 - Input shaft

7. Press bearing cup in input bearing cover.



1 - Input bearing cage

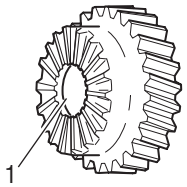
8. If bushing removal is needed, the bushings must exit from the thrust washer side of the helical gear.



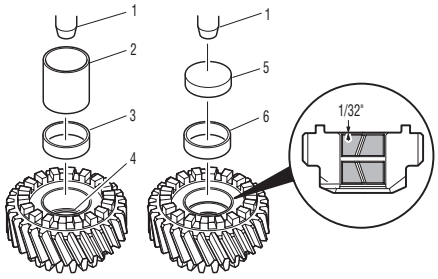
1 - Remove bearing from helical gear

9. Install bushings in helical side gear. **Bushings must be installed from thrust washer side of gear.** See illustration for dimensional tolerances.

Note: Starting in March 1995, helical side gears are designed with a shoulder step that helps prevent bushing walkout. The inner bushing must be installed from the thrust washer side of the helical gear against the shoulder step.

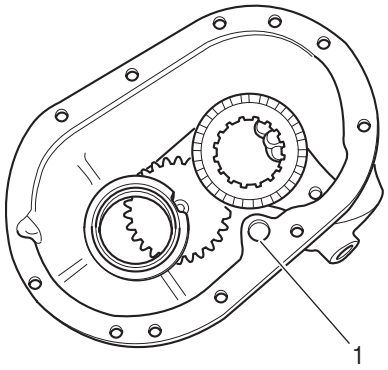


1 - Step added



1 - Press
2 - Sleeve
3 - First bushing (press to shoulder step)
4 - Shoulder
5 - Sleeve
6 - Second bushing (recess 1/32")

10. Check expansion plug in power divider cover to make sure it is in place and firmly seated. If loose, seat by tapping with a hammer. Replace plug if necessary.



1 - Expansions plug

11. Install shift fork in power divider cover.
12. Install lockout cylinder assembly if removed. See Differential Lockout on page 20.
13. Place sliding clutch in power divider cover, engaging clutch with shift fork. Position clutch teeth toward helical side gear.
14. Slide input shaft into power divider cover. Engage shaft splines in lockout sliding clutch. Install bearing spacer on input shaft. Use only on DS440-P, DS460-P, DS480-P.
15. Install input bearing cover and shims.

Note: Input shaft end-play must be adjusted after power divider is assembled to differential carrier. For easier adjustment, temporally install input bearing cage cover and tighten capscrews finger tight. See page 10 for End-play Adjustment.

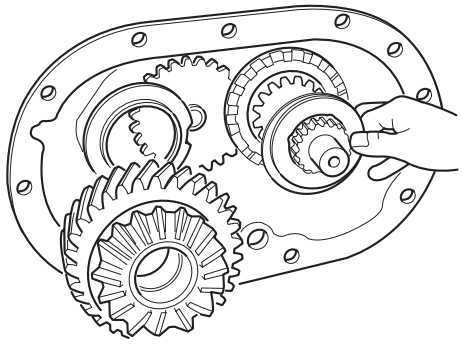
⚠ IMPORTANT

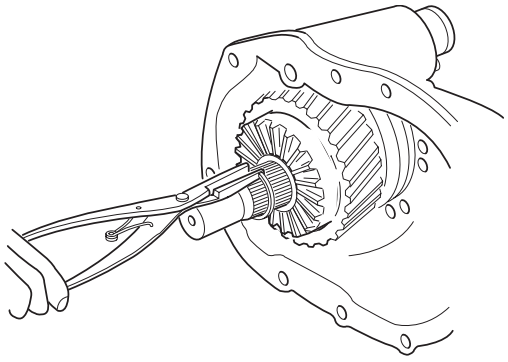
For axles with spring and thrust button between input shaft and output shaft: For preliminary adjustment of input shaft end play, install a 0.045" (0.024 mm) shim pack under bearing cover. See Axial Spring and Spring Button Adjustment Section.

⚠ WARNING

Slide "D" washer over input shaft up to base of sliding clutch splines. Install bronze thrust washer. Install helical side gear. Secure with snap ring.

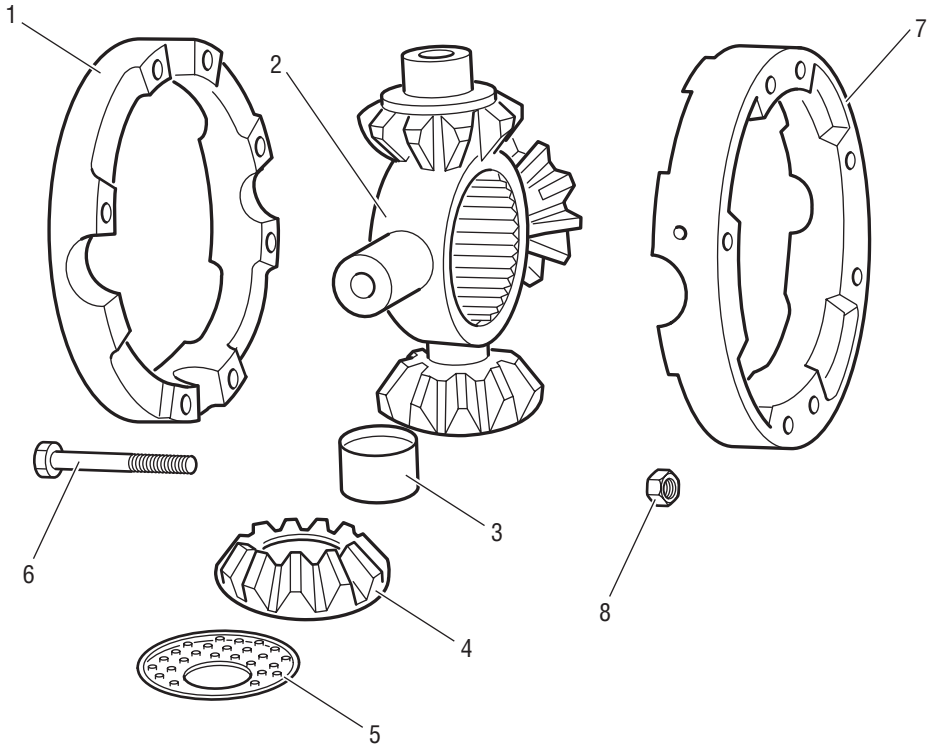
Snap ring is spring steel and may pop off. Wear safety glasses when installing.





16. Install magnetic strainer in power divider cover. Torque to 40-60 lbs. ft. (54-81N•m).

Inter-axle Differential



1 - Case half
2 - Spider
3 - Bushing (use on models built before November 1, 1991)
4 - Side pinion
5 - Thrust washer
6 - Bolt
7 - Case half
8 - Lock nut

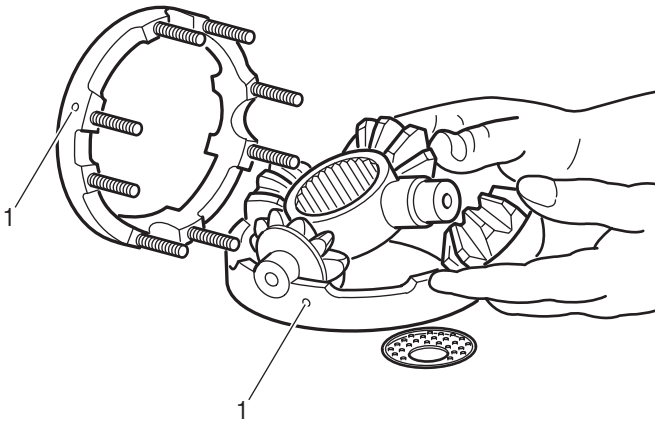
Disassemble Inter-axle Differential

1. Punch mark differential case halves for correct position during reassembly.
2. Remove lock nuts and bolts. Separate case halves and remove thrust washers, side pinions, bushings and spider.

Note: Side pinion bushings are not used on tandem models equipped with lube pumps built after November 1, 1991. Use when originally equipped.

Assemble Inter-axle Differential

1. Install bushings, side pinions and thrust washers on inter-axle differential spider. Pre-lube all components at time of assembly.



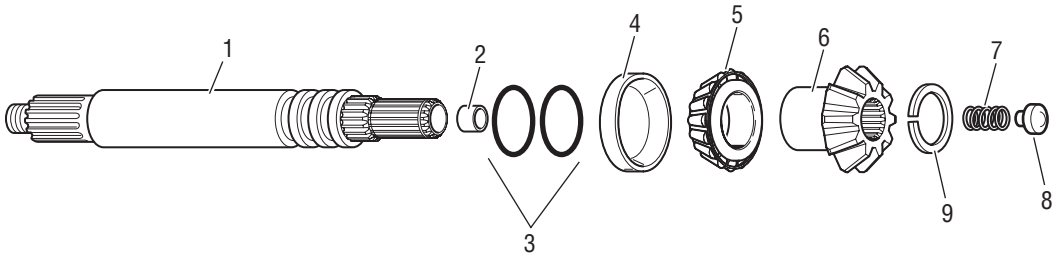
1 - Punch marks

2. Install spider assembly in one differential case half, align punch marks and install other case half. Secure assembly with bolts and lock nuts. Torque to 17-23 lbs. ft. (23-31 N•m).

Note: Side pinion bushings are not used on tandem models equipped with lube pumps built after November 1, 1991. Use when originally equipped.

Output Shaft Assembly

*Bushing removed from production axles in September 1994.
Output shafts with P/N 129016 do not use bushings.



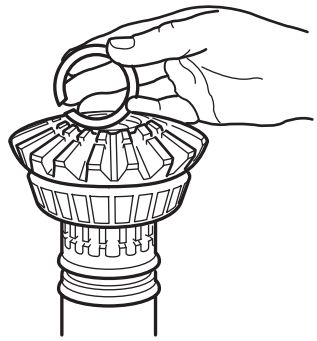
1 - Output shaft
2 - Bushing
3 - O-rings
4 - Bearing cup (mounted in carrier)
5 - Bearing cone
6 - Side gear
7 - Axial spring
8 - Thrust button
9 - Snap ring

Disassemble Output Shaft

⚠ WARNING

Snap ring is spring steel and may pop off. Wear safety glasses when removing.

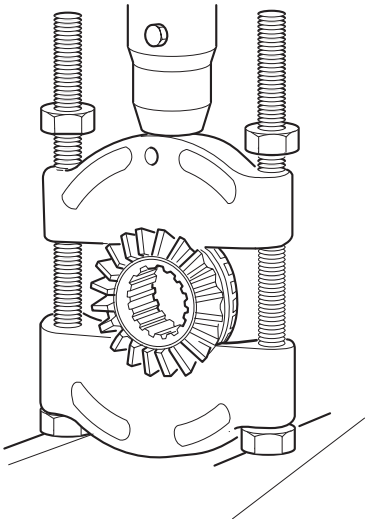
1. Mount shaft assembly in vise, using brass vise jaw protectors. Remove snap ring, side gear and bearing cone assembly.



2. Remove output shaft o-rings. If replacement is necessary, remove bushing mounted in end of output shaft.

Note: Output Shaft Bushings: In September 1994, a bushingless output shaft design change was implemented on production 461, 521 and 581 model axles. Replace bushings only if originally equipped.

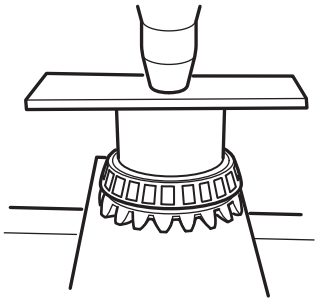
3. Remove bearing cone from side gear using press and split-type puller.



Assemble Output Shaft

Note: Lubricate parts with gear lube during assembly.

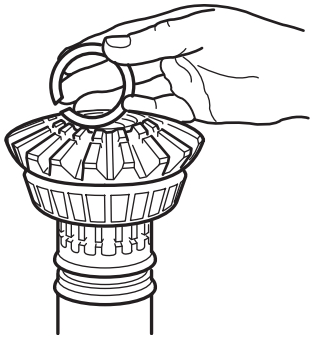
1. Press bearing cone on output shaft side gear.



⚠ CAUTION

Provide protection against possible gear teeth damage during press operation.

2. Mount output shaft in a vise. Lubricate and install o-rings. If removed, install bushing in end of output shaft.



Note: Tandem Axles built after September 1994 are equipped with bushingless output shafts. Verify output shaft design before attempting to install a bushing.

⚠ WARNING

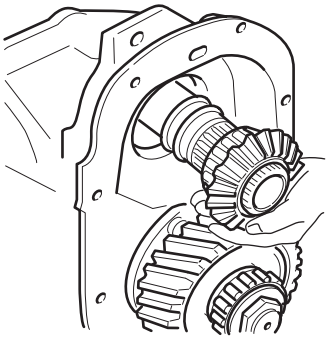
Snap ring is spring steel and may pop off. Wear safety glasses when installing.

3. Install side gear and bearing cone assembly. Install snap ring, be careful not to over stretch the snap ring when installing it into the shaft.

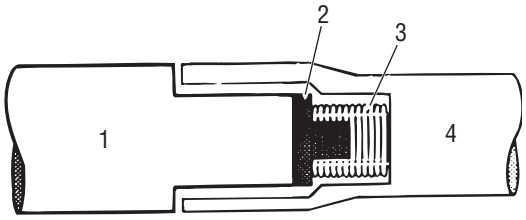
Install Power Divider on Differential Carrier (with carrier assembled to axle housing)

Note: Lubricate all parts before installation.

1. If removed, install axle housing cover and output shaft bearing. For instructions, see Installation of Forward Axle Housing Cover and Output Shaft Bearing Parts on page 14.
2. If output shaft was removed, lubricate o-rings, then install shaft assembly in differential carrier and housing cover. Lubricate seal lip. Make sure yoke is clean and dry, then install yoke and self-locking nut. Torque nut to 840-1020 lbs. ft. (1139-1383 N•m).



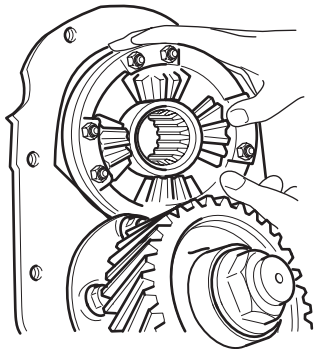
3. Insert axial spring and thrust button in the end of the output shaft



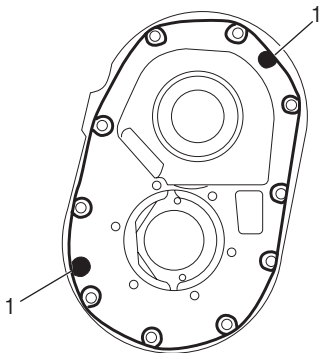
1 - Input shaft
2 - Thrust button (Part #51228)
3 - Axial spring (Part #51238)
4 - Output shaft

Note: Late model axles may be equipped with axial spring and thrust button mounted between input and output shafts. See page 43.

4. Install inter-axle differential on output shaft side gear (with nuts facing away from side gear).



5. Use silicone rubber gasket compound on differential carrier mating surface.



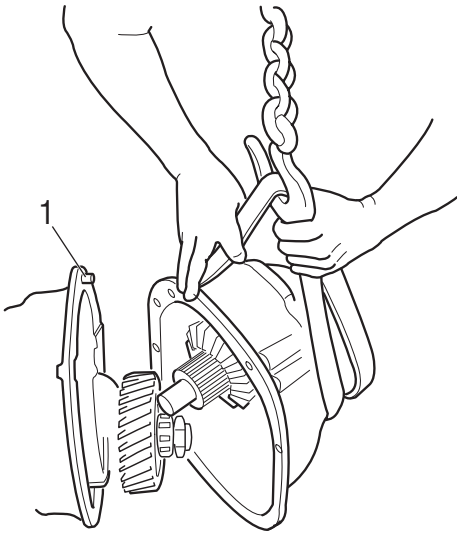
1 - Dowel pin

Note: Gasket compound will set in 20 minutes. Install power divider before compound sets or reapply.

⚠ CAUTION

During installation of the power divider, the inter-axle differential may fall from the carrier. Exert caution to prevent damage or injury.

6. Make certain dowel pins are installed in carrier, then install power divider assembly.



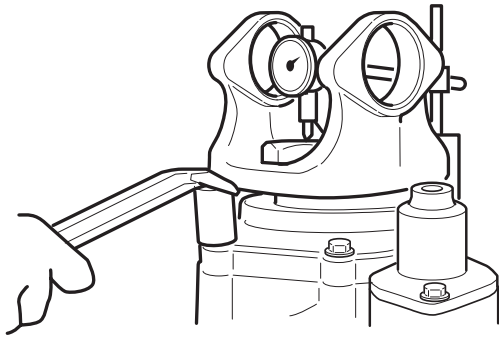
1 - Dowel pin

TIP: During installation, rotate input shaft to engage input shaft splines with inter-axle differential. After assembly output shaft should turn when input shaft is rotated, and output shaft should turn independently from the input shaft.

TIP: The use of two guide pins in the carrier mating surface will help align the PDU cover and aid in installation. Guide pins may be made from 9/16"-12 UNC bolts approximately four inches long with the heads removed.

7. Install power divider capscrews. Torque hex head capscrew to 110-125 lbs. ft. (149-169 N•m) and socket head capscrew to 115-125 lbs. ft. (155-169 N•m).

8. Check and adjust input shaft end play. With power divider assembled to differential carrier, check end play with dial indicator. End play should be 0.003" to 0.007". If necessary, adjust (see page 43). After end play is within specifications, complete assembly procedures as follows:



9. Connect main driveline and inter-axle driveline.
10. Connect all applicable lines:
    - IAD lockout
    - Differential lock shift unit
11. Fill axle to proper lube level (see Lube Fill Capacities on page 104).

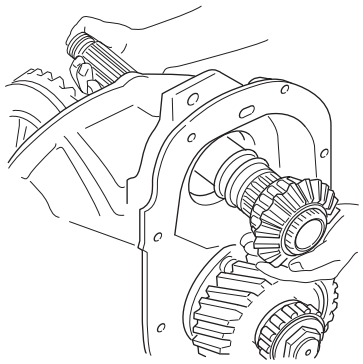
⚠ IMPORTANT

When the axle has been disassembled or the housing, gears, axle shafts or wheel equipment replaced, check axle assembly for proper differential action before operating vehicle. Wheels must rotate freely and independently.

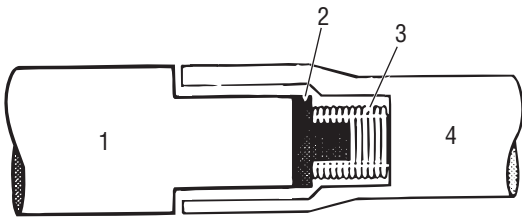
Install Power Divider on Differential Carrier (with carrier removed from axle housing)

The following instructions pertain to installation of power divider on differential carrier with carrier removed from axle housing.

1. If output shaft side gear bearing cup was removed, press bearing cup in carrier. Use a press and appropriate sleeve or use a brass drift and a mallet. Tap bearing cup into its bore making certain cup is evenly and firmly seated.
2. Lubricate o-rings, then install output shaft assembly in carrier.



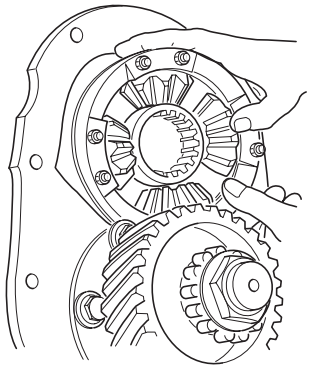
3. Insert axial spring and thrust button in the end of the output shaft.



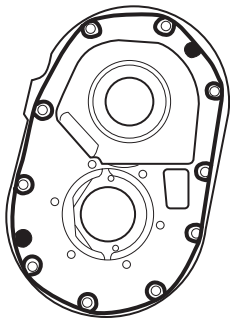
1 - Input Shaft
2 - Thrust button (Part #51228)
3 - Axial spring (Part #51238)
4 - Output shaft

Note: Early model axles may not be equipped with axial spring and thrust button. If your axle was not equipped with these parts, go to step 4.

4. Install inter-axle differential assembly on output shaft side gear (with nuts facing away from output shaft side gear).

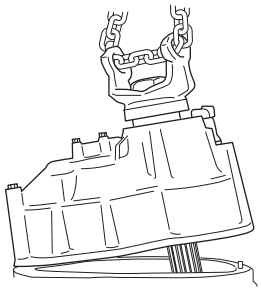


5. Apply silicone gasket compound on carrier mating surface.



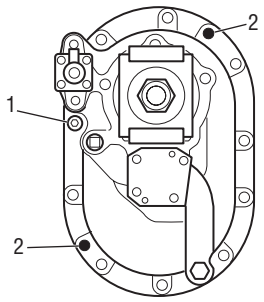
Note: Gasket compound will set in 20 minutes. Install power divider before compound sets or reapply.

6. Attach chain hoist to input yoke and install power divider assembly. During installation, rotate input shaft to engage input shaft splines with inter-axle differential. After installation, rotate input shaft again. Output shaft should turn when input shaft is rotated if assembly is correct.



Note: Lifting mechanism may create nicks and burrs on input yoke. Remove if present.

7. If removed, install dowel pins in carrier. Install power divider cover capscrews and lock washers placing sockethead capscrew at location shown on drawing. Torque capscrews to appropriate specification. (See Torque Chart on page 107).



1 - Socket head capscrew
2 - Dowel pin

Note: For power dividers equipped with an input shaft tapered roller bearing, adjust shaft end play after power divider cover is assembled to differential carrier. Refer to page 43.

Measure and Adjust Input Shaft End-Play

Note: After power divider overhaul and installation on carrier, check and adjust input shaft end-play.

Input Shaft End Play Chart	
New or Rebuild with new parts **0.003" to 0.007"**	**NOTE:** Because of manufacturing variations in individual parts, correctly adjusted end-play could vary 0.010", after the unit is rotated.
Acceptable End-Play Tolerances when measuring as a regular maintenance procedure with axle in truck.	
Up to 0.060" with over 100,000 miles or 1 year service off-road	**NOTE:** If end-play exceeds limits, disassemble power divider and replace worn parts.
Up to 0.040" with less than 100,000 miles or 1 year service on-road	

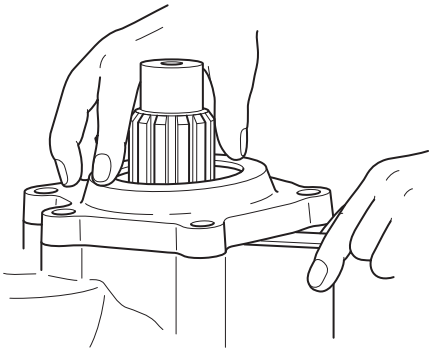
Without Input Shaft Axial Spring Thrust Button

⚠ CAUTION

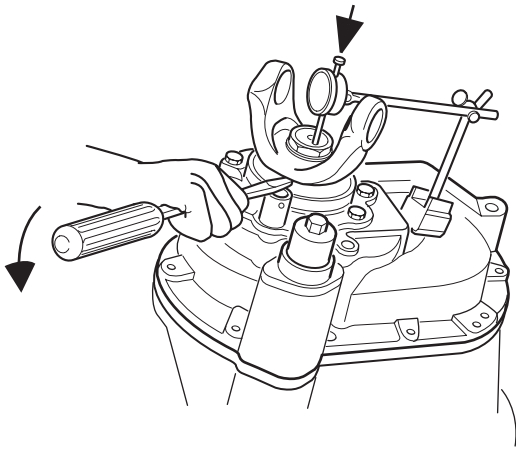
In September 1988, a axial spring and thrust button were added between the input and output shafts. End-play tolerances are the same for axles with or without this spring and button. However, end-play measurement procedure is different than described here. Refer to page 44 of this manual for procedure variances.

The correct end-play when new parts are used in overhaul is 0.003" to 0.007", with reused parts the maximum is 0.14".

1. Remove input shaft nut, flat washer and yoke. Remove input bearing cover capscrews. Remove bearing cover (and shim pack if installed).
2. Reinstall bearing cover without shims. Hold in position with hand pressure and measure clearance between power divider cover and bearing cover, using a feeler gauge.



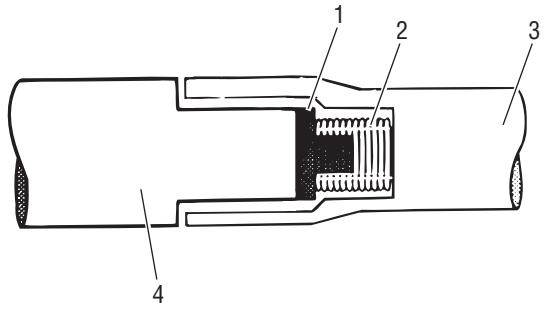
3. The bearing cover clearance measured in Step 2 plus 0.005" will equal shim pack thickness required for desired end-play (rebuild with new parts). Add 0.015" to shim pack for rebuild with used parts.
4. Install shim pack and bearing cover. Install capscrews. Torque screws to 75–85 lbs. ft. (101–115 N•m). Make sure shims are flat with no kinks or bends.
5. Install yoke. Tighten nut snugly. Tap end of input shaft lightly to seat bearings.
6. Check input shaft end-play with dial indicator positioned at yoke end of input shaft. Move input shaft axially and measure end-play. If end-play is correct, seal shim pack with Dana approved RTV compound to prevent lube leakage. Then torque input shaft nut.



With Input Shaft Axial Spring Thrust Button

In September 1988, Spicer added an axial spring and thrust button between the input and output shafts. The addition of these parts reduces shaft end play movement by loading the shafts axially in the direction of the yoke. End play tolerances are the same for axles with or with out the new spring and thrust button. However, end play measurement procedure is different as described below.

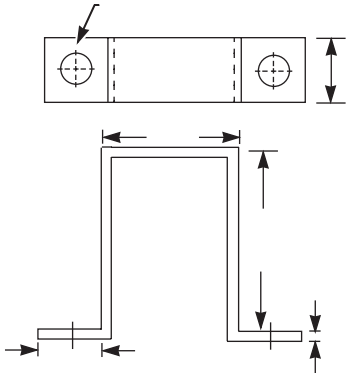
Note: As of September 1994, production and service output shafts for the D461, 521 and 581 models are no longer produced with a bushing in the end of the shaft. The shafts can be identified by part number, see Output Shaft Assembly on page 38 for more information.



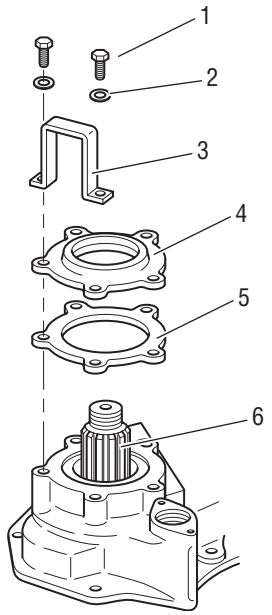
1 - Thrust button
2 - Axial spring
3 - Output shaft
4 - Input shaft

Input Shaft Axial Spring

1. Fabricate a U-bracket from 1 in. flat stock (minimum thickness 0.125") as specified in the illustration.
2. If axle is assembled, first remove input shaft nut, flat washer and yoke.
3. Build up a 0.045" (0.024 mm) thick shim pack and place shim pack and bearing cover on power divider cover.

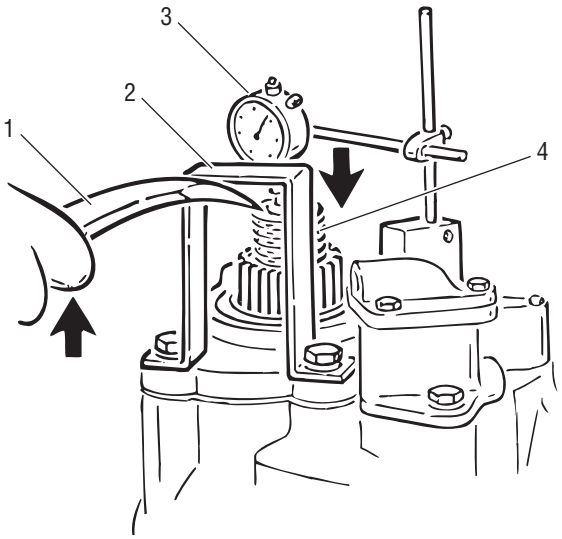


4. Install the U-bracket on bearing cover, using two bearing cover capscrews. Install all other cover capscrews and torque to 75-85 lbs. ft. (101-115 N•m).



1 - Bearing cover capscrew
2 - Lock washer
3 - Fabricated U-bracket
4 - Inner bearing cover
5 - Input bearing cover shim(s)
6 - Input shaft

5. Position a dial indicator on the end of the input shaft.



1 - Pry bar
2 - U-bracket
3 - Dial indicator
4 - Input shaft

6. Lift up on pry bar to compress input shaft.
7. Insert a pry bar through the U-bracket with the end of the bar resting on the end of the input shaft.
8. Zero the dial indicator and lift up on the pry bar to move the input shaft axially until it bottoms out within the bearing cover. Measure the end-play.
9. If the end-play is acceptable, remove U-bracket and bearing cover. Seal shim pack to prevent lube leakage. Reinstall bearing cover and capscrews. Torque capscrews to 75-85 lbs. ft. (101-115 N•m). Continue axle assembly as necessary.
10. If end-play is incorrect, change shim pack size as follows:

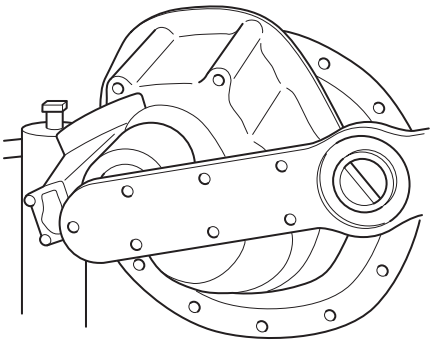
Add shims to increase end-play

Desired end-play (New Parts)	0.003" to 0.007"
Measured end-play (Step 6)	0.001” – 0.001”
Add shims to provide desired end-play	0.002" to 0.006"

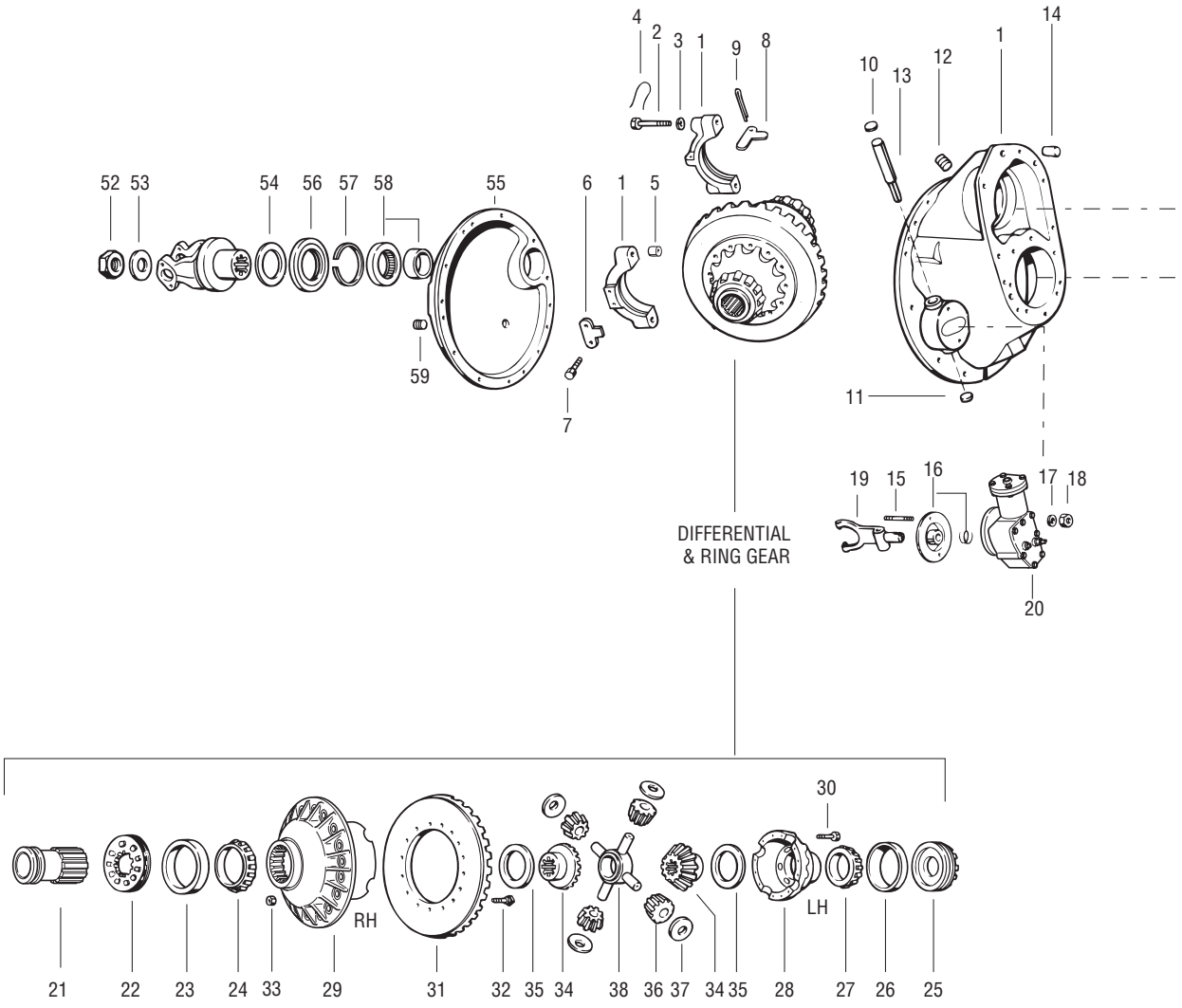
Remove shim to decrease end-play

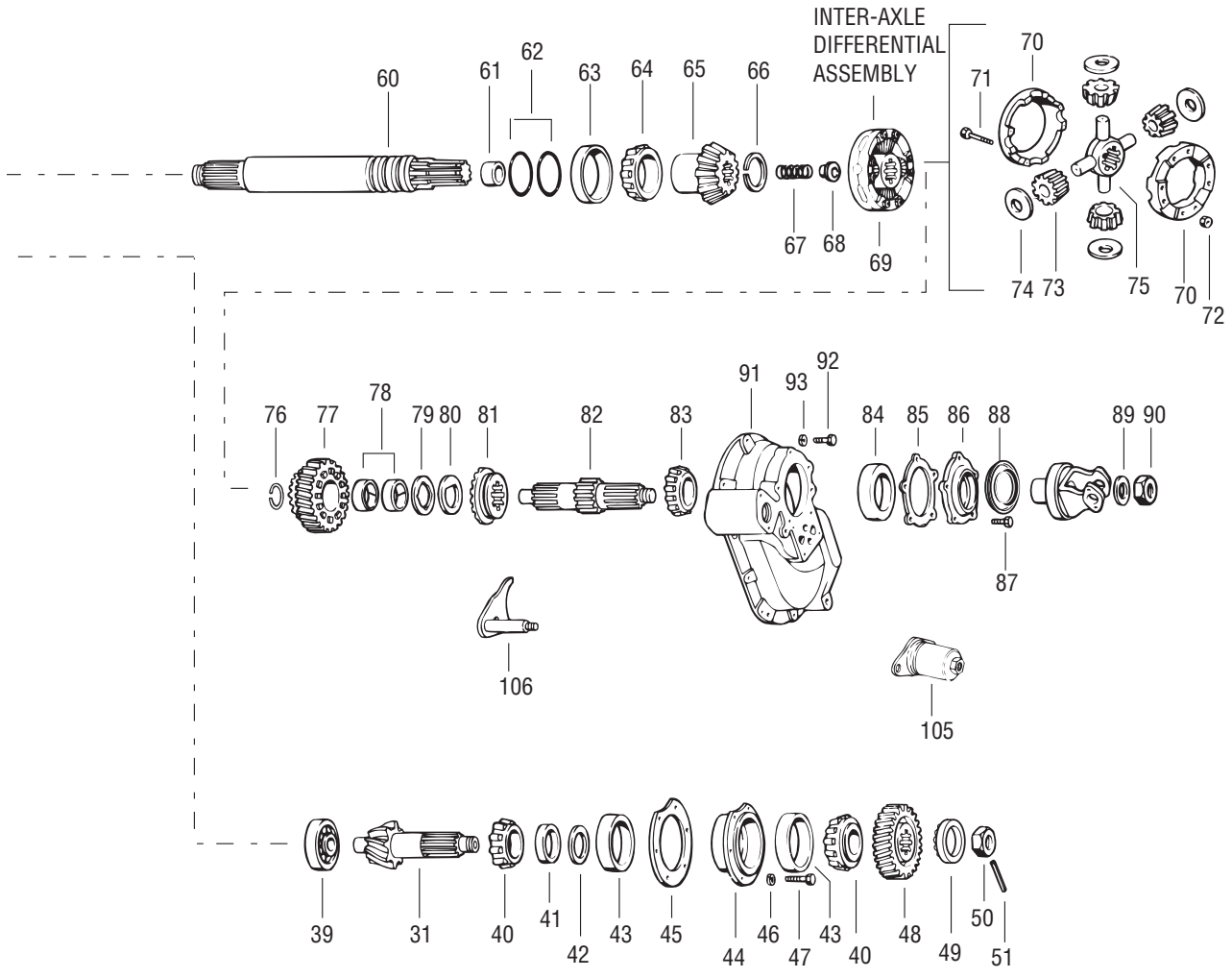
Measured end-play (Step 6)	0.015" – 0.015"
Desired end-play (New Parts)	0.003” to 0.007”
Remove shims to provide desired end-play	0.012” to 0.008”

11. To add or remove shims, remove input shaft nut, flat washer and yoke. Remove capscrews, lock washers and bearing cover. Add or remove shims as required.
12. Install bearing cover and capscrews. Seal shim pack with Dana approved RTV compound to prevent lube leakage then torque input shaft capscrews 75–85 lbs. ft. (101–115 N•m).
13. Install yoke.
14. Install new yoke nut with the pre-applied thread adhesive compound. Tighten the nut to the specified torque 840–1020 lbs. ft. (1148–1383 N•m).



Forward Axle Carrier Assembly (Single Speed) with Diff. Lock - Parts Exploded View




INTER-AXLE
DIFFERENTIAL
ASSEMBLY
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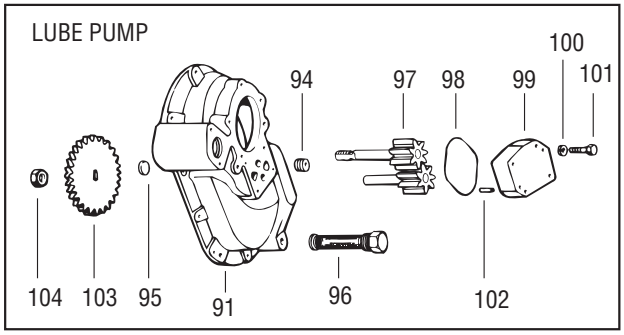
LUBE PUMP
100
101
94
97
98
99
104
103
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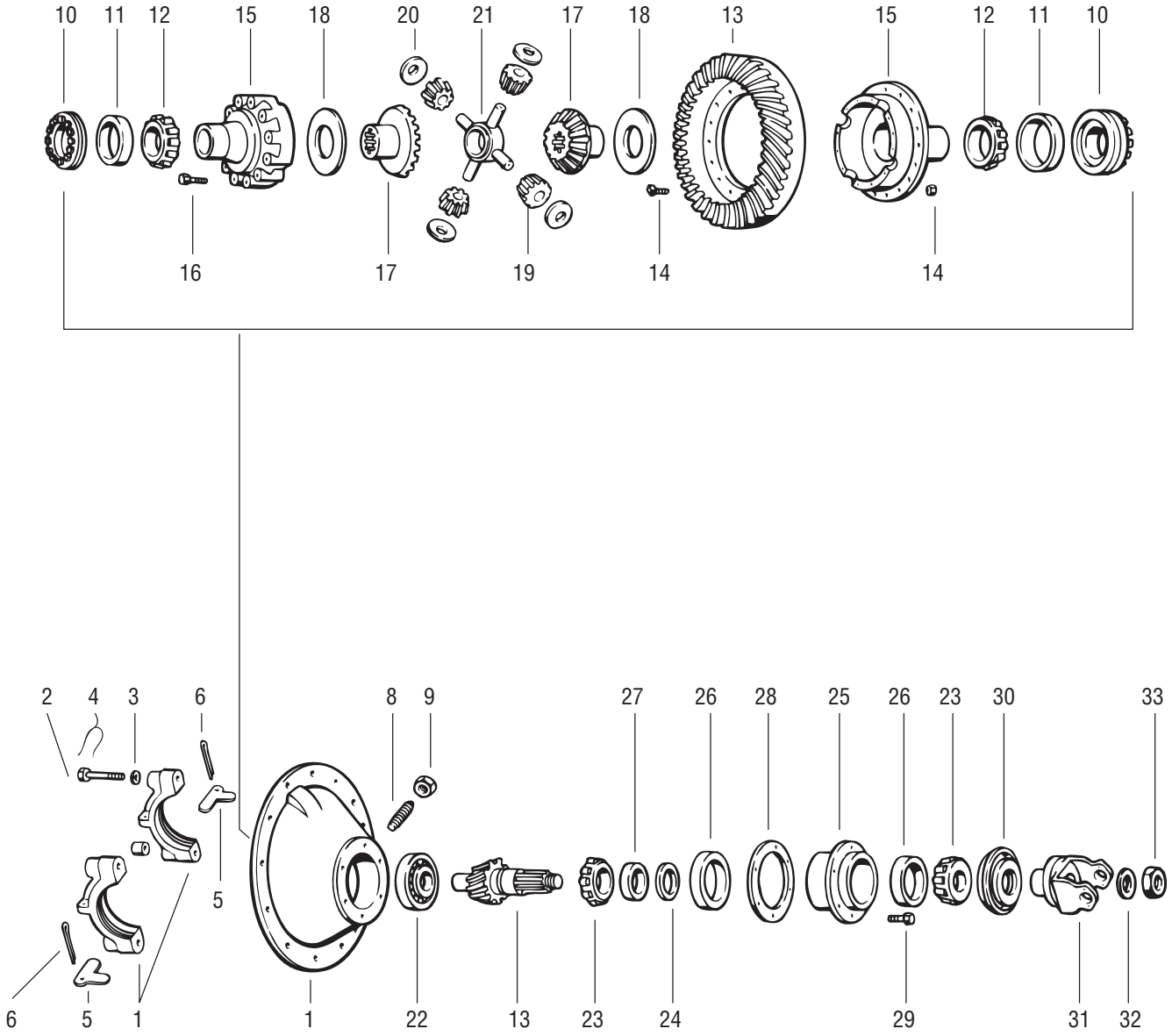
91
96
102

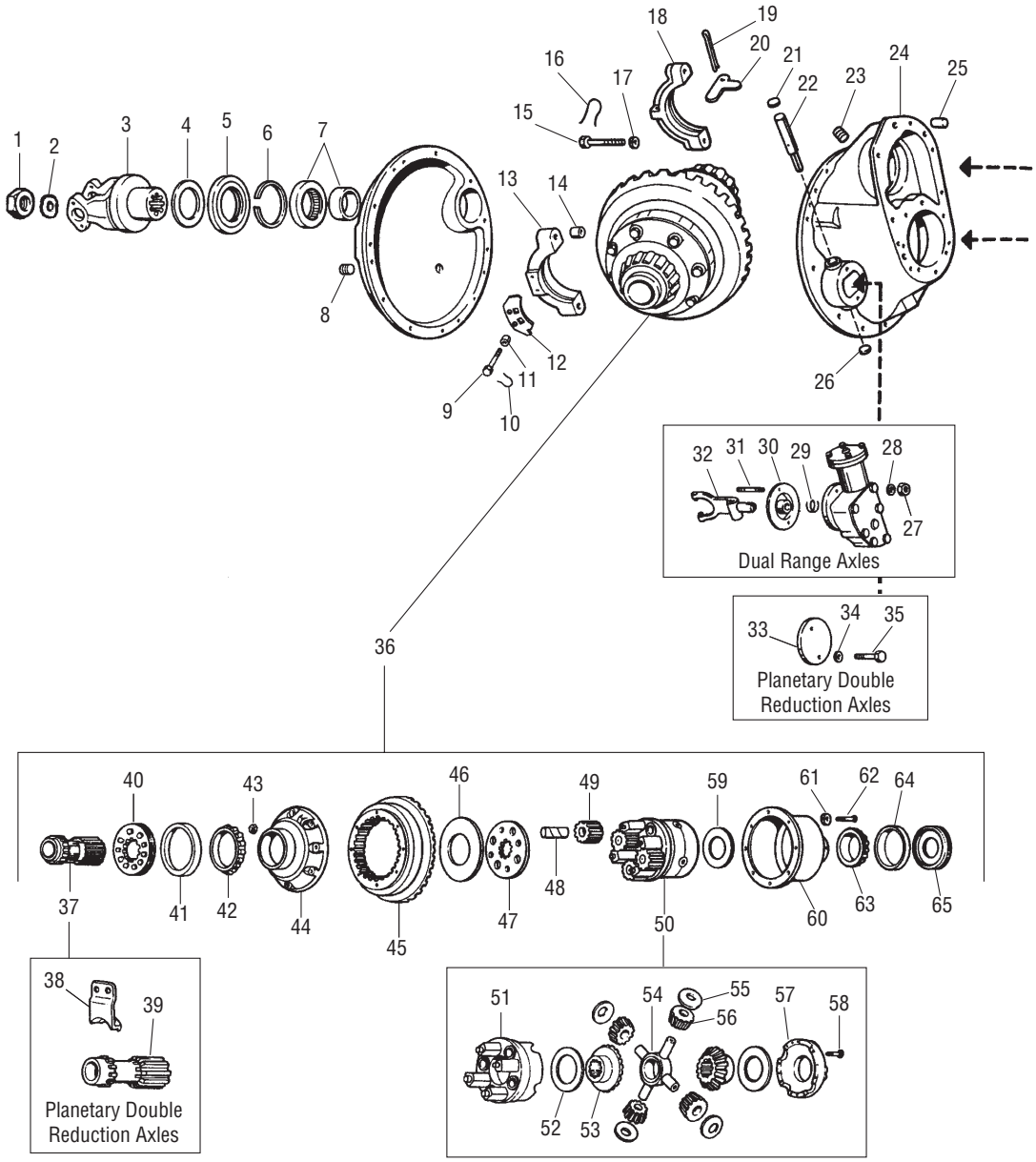
1 - Differential carrier & bearing caps
2 - Bearing capscrew
3 - Flat washer
4 - Lockwire
5 - Dowel bushing
6 - Bearing cap adjuster lock (RH)
7 - Capscrew
8 - Bearing cap adjuster lock (LH)
9 - Cotter pin (LH)
10 - Expansion plug (upper)
11 -Expansion plug (lower)
12 - Filler plug
13 - Shift fork shaft
14 - Carrier cover dowel pun
15 - Shift unit mounting stud
16 - Shift fork seal & spring assembly
17 - Flat washer
18 - Stud nut
19 - Shift fork & roller assembly
20 - Shift unit assembly
21 - Sliding clutch
22 - Differential bearing adjuster (RH)
23 - Differential bearing cup (RH)
24 - Differential bearing cone (RH)
25 - Differential bearing adjuster (LH)
26 - Differential bearing cup (LH)
27 - Differential bearing cone (LH)
28 - Differential case (plain half)
29 - Differential case (flanged half)
30 - Differential case capscrew
31 - Ring gear & drive pinion
32 - Bolt
33 - Nut
34 - Differential side gear
36 - Side pinion
37 - Side pinion thrust washer
38 - Spider
39 - Pinion pilot bearing
40 - Pinion bearing cone
41 - Pinion bearing spacer washer
42 - Pinion bearing spacer
43 - Pinion bearing cup
44 - Pinion bearing cage
45 - Pinion bearing cage shim
46 - Lock washer
47 - Bearing cage capscrew
48 - Pinion helical gear
49 - Outer pinion support bearing (one piece)
50 - Pinion shaft end nut
51 - Pinion nut spring pin
52 - Output shaft nut
53 - Output shaft washer
54 - Rear bearing retaining washer
55 - Axle housing cover
56 - Output shaft oil seal
57 - Bearing snap ring
58 - Output shaft bearing
59 - Filler plug
60 - Output shaft
61 - Output shaft bushing
62 - Output shaft O-ring
63 - Output shaft bearing cup
64 - Output shaft bearing cone
65 - Output shaft side gear
66 - Side gear snap ring
67 - Output shaft compression spring
68 - Output shaft thrust bearing
69 - Inter-axle differential assemble
70 - Inter-axle differential case half
71 - Case bolt
72 - Case nut
73 - Side pinion
74 - Side pinion thrust washer
75 - Spider
76 - Helical side gear snap ring
77- Helical side gear
78 - Helical side gear bushing
79 - Helical side gear thrust washer
80 - Helical side gear “D” washer
81 - Lockout sliding clutch
82 - Input shaft
83 - Input shaft bearing cone
84 - Input shaft bearing cup
85 - Input cover shim
86 - Input bearing cover
87 - Bearing cover capscrew
88 - Input shaft oil seal
89 - Input shaft nut washer
90 - Input shaft nut
91 - PDU carrier cover
92 - Carrier cover capscrew
93 - Lock washer
94 - Pipe plug
95 - Expansion plug
96 - Magnetic filter screen
97 - Pump gear & shaft assembly
98 - Cover O-ring
99 - Lube pump cover
100 - Lock washer
101 - Cover capscrew
102 - Cover dowel pin
103 - Pump drive gear
104 - Drive gear locknut
105 - Air-operated lockout assembly
106 - Shift fork & push rod assembly

Rear Axle (Single Speed) - Parts Exploded View



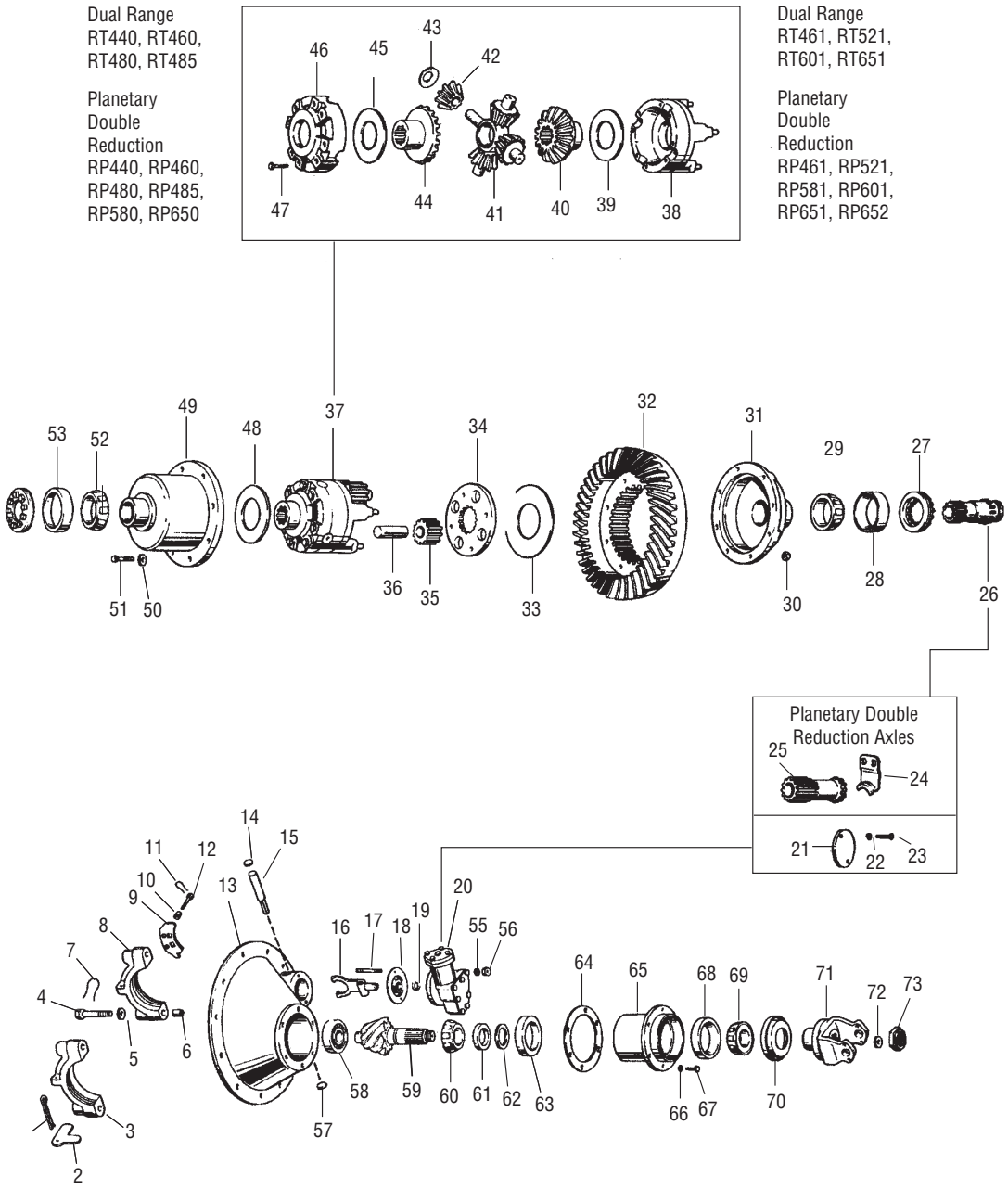
1 - Differential carrier & bearing caps
2 - Bearing capscrew
3 - Flat washer
4 - Lockwire
5 - Bearing cap adjuster lock
6 - Cotter pin
7 - Dowel bushing
8 - Ring gear thrust screw
9 - Thrust screw jam nut
10 - Differential bearing adjuster
11 - Differential bearing cup
12 - Differential bearing cone
13 - Ring gear & drive pinion
14 - Bolt and nut
15 - Differential case (flanged half)
16 - Differential case capscrew
17 - Differential side gear
18 - Side gear thrust washer
19 - Side pinion
20 - Side pinion thrust washer
21 - Spider
22 - Pinion pilot bearing
23 - Pinion bearing cone
24 - Pinion bearing spacer
25 - Pinion bearing cage
26 - Pinion bearing cup
27 - Pinion bearing spacer washer
28 - Pinion bearing cage shim
29 - Bearing cage capscrew
30 - Oil seal
31 - Input yoke
32 - Flat washer
33 - Pinion nut

Forward Axle (Two Speed) - Parts Exploded View



1 - Nut
2 - Washer (used on DT461-P, DT652P, DP461-P, DP652-P)
3 - Yoke
4 - Bearing retainer washer (used on DT440-P, DT485-P, DP440-P, DP650-P)
5 - Oil seal
6 - Snap ring
7 - Bearing & sleeve
8 - Filler plug
9 - Capscrew
10 - Lockwire
11 - Dowel bushing
12 - Adjuster lock
13 - Bearing cap
14 - Dowel bushing
15 - Capscrew
16 - Lockwire
17 - Flat washer
18 - Bearing cap
19 - Cotter pin
20 - Adjuster lock
21 - Expansion plug
22 - Shift fork shaft
23 - Filler plug
24 - Differential carrier
25 - Dowel pin
26 - Expansion plug
27 - Nut
28 - Lock washer
29 -Seal spring
30 - Seal
31 - Stud
32 - Shift fork
33 - Shift fork cover
34 - Lock washer
35 - Capscrew
36 - Differential & ring gear
37 - Sliding clutch (dual range only)
38 - Retainer
39 - Sun gear
40 - Bearing adjuster
41 - Bearing cup
42 - Bearing cone
43 - Ring gear nut
44 - Gear support case
45 - Ring gear
46 - Thrust washer
47 - High-speed clutch plate
48 - Idler pinion pin
49 - Idler pinion
50 - Differential assembly
51 - Differential case with pins
52 - Thrust washer
53 - Side gear
54 - Spider
55 - Thrust washer
56 - Side pinion
57 - Plain differential assembly
58 - Capscrew
59 - Thrust washer
60 - Gear support case
61 - Washer
62 - Ring gear bolt
63 - Bearing cone
64 - Bearing cup
65 - Bearing adjuster

Rear Axle (Two Speed) - Parts Exploded View

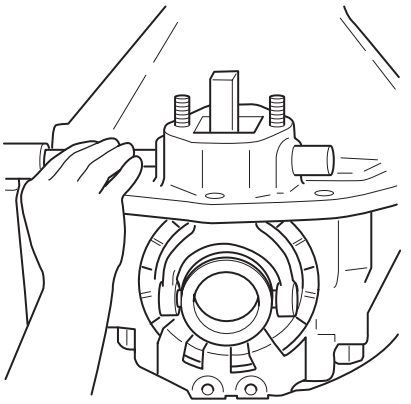


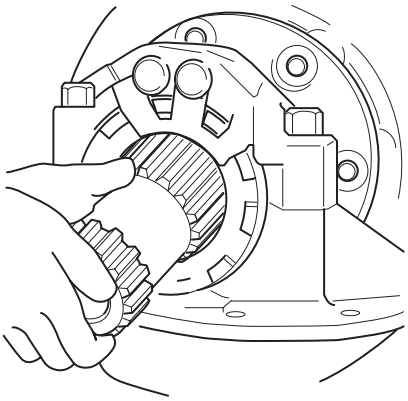
1 - Cotter pin
2 - Adjusting lock
3 - Bearing cap
4 - Capscrew
5 - Flat washer
6 - Dowel bushing
7 - Lockwire
8 - Bearing cap
9 - Adjusting lock
10 - Dowel bushing
11 - Lockwire
12 - Capscrew
13 - Differential carrier
14 - Expansion plug
15 - Shift fork shaft
16 - Shift fork
17 - Stud
18 - Seal
19 - Seal spring
20 - Shift unit
21 - Shift fork cover
22 - Lock washer
23 - Capscrew
24 - Retainer
25 - Sun gear
26 - Sliding clutch (dual range)
27 - Bearing adjuster
28 - Bearing cup
29 - Bearing cone
30 - Ring gear nut
31 - Gear support case (LH)
32 - Ring gear
33 - Thrust washer
34 - High-speed clutch plate
35 - Idler pinion
36 - Idler pinion pin
37 - Differential assembly
38 - Differential case with pins (LH)
39 -Thrust washer
40 - Side gear
41 - Spider
42 - Side pinion
43 - Thrust washer
44 - Side gear
45 - Thrust washer
46 - Plain differential case (RH)
47 - Capscrew
48 - Thrust washer
49 - Gear support case (RH)
50 - Washer
51 - Ring gear bolt
52 - Bearing cone
53 - Bearing cup
54 - Bearing adjuster
55 - Lock washer
56 - Nut
57 - Expansion plug
58 - Pilot bearing
59 - Drive pinion
60 - Bearing cone
61 - Spacer washer
62 - Bearing spacer (variable)
63 - Bearing cup
64 - Bearing cage shim
65 - Bearing cage
66 - Lock washer
67 - Capscrew
68 - Bearing cup
69 - Bearing cone
70 - Oil seal
71 - Yoke
72 - Flat washer (use on RT461, RT651, RP461, RP652)
73 - Pinion nut

Disassemble Differential Carrier (with power divider removed)

Dual range axles only

1. Remove shift fork seal and spring.
2. Remove expansion plugs.
3. Working at the lower (or small) plug hole, drive out the shift fork shaft.
4. Disengage shift fork yoke from sliding collars.
5. Remove clutch and shift fork.





Planetary double reduction axles

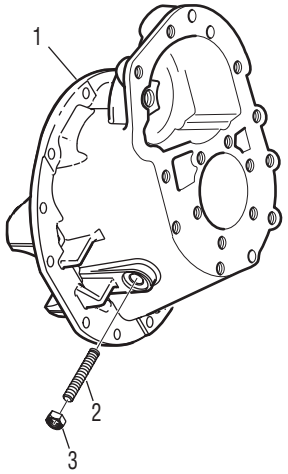
A sun gear is used in place of sliding clutch gear. To remove sun gear:

1. Remove capscrews and the retainer which holds gear in position.
2. Remove sun gear.

Models with Ring Gear Thrust Bolt

Note: If the carrier model has a ring gear thrust bolt installed, it must be backed away from the ring gear before you can remove the wheel differential.

1. Back off thrust bolt jam nut.
2. Back out thrust bolt from the carrier until the end of the bolt is flush with the inside of the carrier casting. This will allow enough clearance between the ring gear and the carrier pilot web.

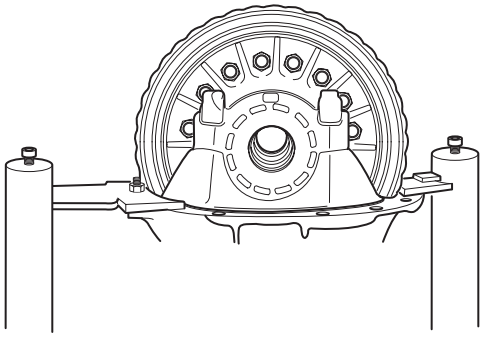


1 - D-head carrier or front carrier
2 - Thrust bolt
3 - Thrust bolt jam nut

Remove Wheel Differential (All Standard Models)

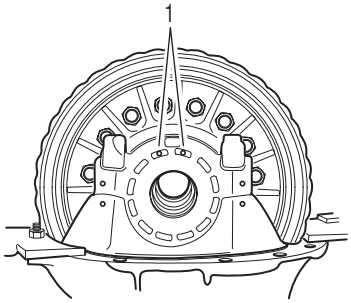
Note: If gear set is to be reused, check tooth contact pattern and ring gear backlash before disassembling differential carrier. When checking backlash, a yoke or helical gear must be installed and torqued to get an accurate reading. Best results are obtained when established wear patterns are maintained in used gearing. Omit this step if the gear set is to be replaced.

1. Mount differential carrier in repair stand.



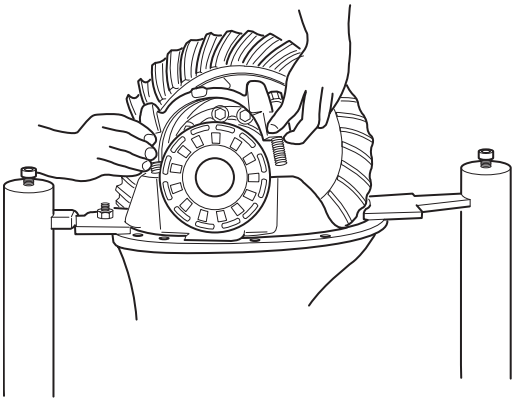
Note: For easier disassembly, loosen but do not remove pinion (self-locking) nut. Forward axle pinion is equipped with slotted nut, remove roll pin with a pin punch then loosen nut.

2. Punch mark bearing caps. If reusing gear set, also punch mark bearing adjusters for reference during assembly.

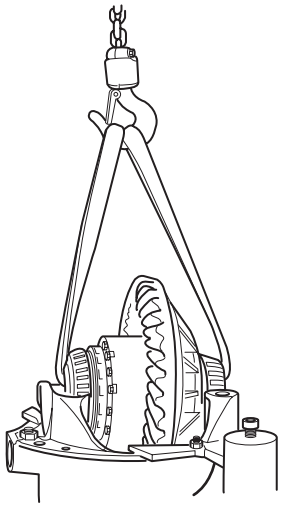


1 - Punch marks

3. Cut lockwire. Remove capscrews, flat washers and bearing caps. Back off bearing adjusters and remove adjusters and bearing cups.

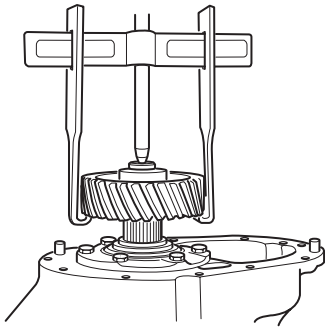


4. Using a chain hoist, lift ring gear and differential assembly out of carrier.



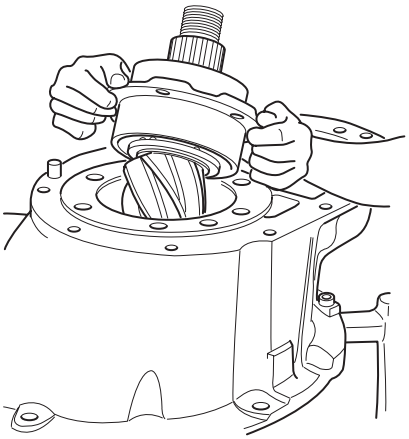
Remove Pinion Assembly

1. **Forward Axle:** Remove pinion nut. Remove helical drive gear using puller. Remove helical gear spacer (D440-P and D560-P only).



Note: For easier disassembly, loosen but do not remove pinion (self-locking) nut. Forward axle pinion is equipped with slotted nut, remove roll pin with a pin punch then loosen nut.

2. Remove pinion bearing cage capscrews. Remove pinion and cage assembly from carrier. Remove shim pack.



⚠ IMPORTANT

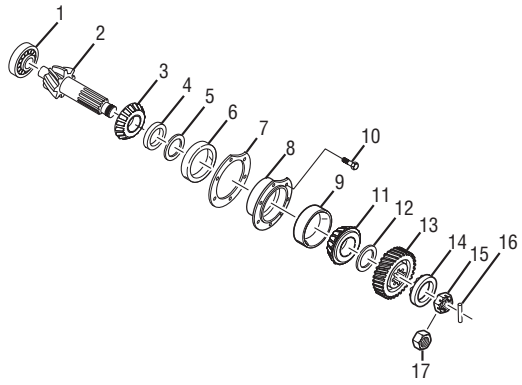
Forward and Rear Axle: If gear set is to be reused, keep pinion bearing cage shim pack intact for use in reassembly. If the original shims cannot be reused, record the number and size of shims in the pack.

Do not allow pinion to drop on hard surface.

3. **Forward Axle:** Pilot Bearing Sleeve (Early Models Only): If replacement is necessary, remove capscrews, locks and pilot bearing sleeve from carrier.

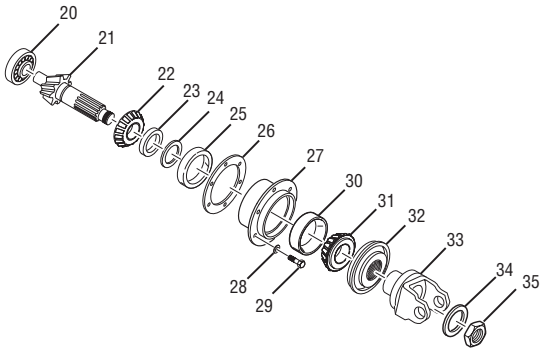
Drive Pinion - Parts Exploded View

Front Axle Pinion Assembly



1 - Pinion pilot bearing
2 - Pinion
3 - Pinion bearing cone - inner
4 - Pinion bearing spacer
5 - Bearing spacer variable
6 - Pinion bearing cup - inner
7 - Shim
8 - Pinion bearing cage
9 - Pinion bearing cup - outer
10 - Capscrew
11 - Pinion bearing cup - outer
12 - Helical gear spacer
13 - Pinion helical gear
14 - One piece bearing
15 - Slotted pinion nut
16 - Roll pin
17 - Pinion self locking nut

Rear Axle Pinion Assembly



18 - Pinion pilot bearing
19 - Pinion
20 - Pinion bearing cone - inner
21 - Pinion bearing spacer
22 - Bearing spacer variable
23 - Pinion bearing cup - inner
24 - Shim
25 - Pinion bearing cage
26 - Lock washer
27 - Capscrew
28 - Pinion bearing cup - outer
29 - Pinion bearing cone - outer
30 - Oil seal
31 - Yoke
32 - Flat washer
33 - Pinion nut

Disassemble and Overhaul Drive Pinion

The following procedures cover both forward and rear differential drive carrier assembly.

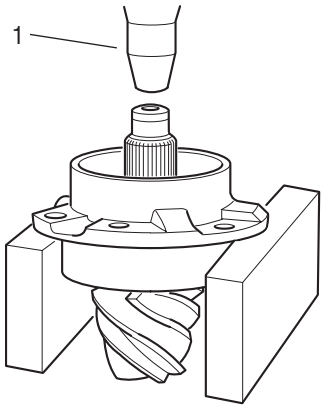
Note: Dana drive axles may be equipped with either “press-fit” or “slip-fit” outer pinion bearings. Procedures are contained in this section for assembly of both types.

1. **Rear Axle Pinion Yoke:** Remove yoke.
2. If pinion nut was not loosened during earlier disassembly, clamp assembly in vise jaws, use brass pads to prevent damage. Loosen and remove pinion nut and flat washer. Remove yoke from pinion.

⚠ CAUTION

If pinion nut was not loosened during earlier disassembly, clamp assembly in vise jaws, use brass pads to prevent damage.

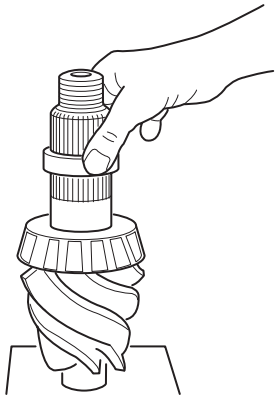
3. Loosen and remove pinion nut and flat washer. Remove yoke from pinion using an appropriate tool.
4. **Forward and Rear Axle Pinion Bearing Cage:**
   - Press-fit. Press pinion out of bearing cage and bearing cone.



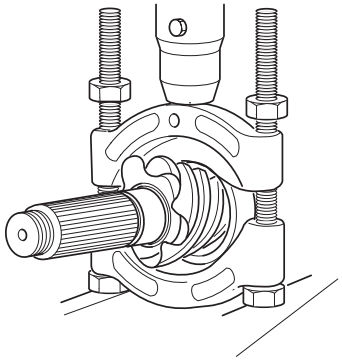
1 - Press ram

   - Slip-fit. For pinion with “slip-fit” bearing cone, the cage, outer bearing and pinion can usually be disassembled easily without a press. If difficulty is experienced, use a press.

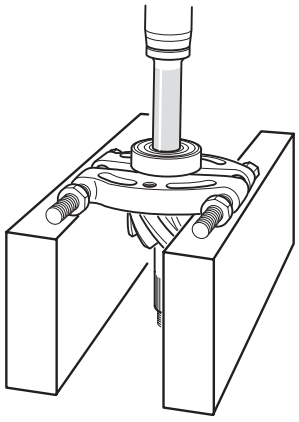
5. **Rear Axle Pinion Oil Seal and Outer Bearing Cone:** Remove oil seal and bearing cone from cage. Discard oil seal. Remove bearing cups with suitable puller.
6. Remove bearing spacer and spacer washers from pinion.



7. Remove pilot bearing from pinion using a split-type puller. Use two procedure steps to remove each bearing.
   a. Mount puller vertically to separate the bearing. This action will force puller halves under bearing and start moving bearing off pinion.

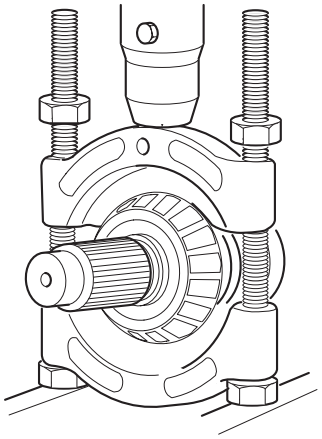


   b. Mount puller horizontally to press pinion out of bearing.

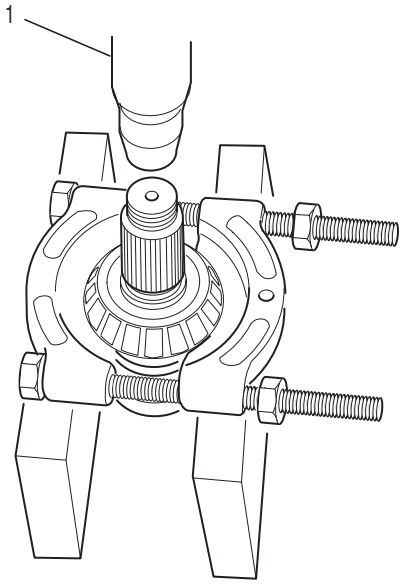


8. Remove inner bearing cone from pinion using a split-type puller. Use two procedure steps to remove each bearing.

   a. Mount puller vertically to separate the bearing. This action will force puller halves under bearing and start moving bearing off pinion.

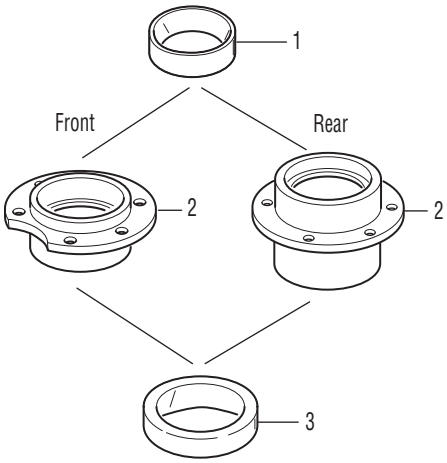


   b. Mount puller horizontally to press pinion out of bearing.



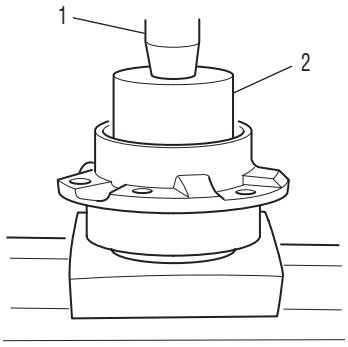
1 - Press

Replace Pinion Bearing Cage Cups



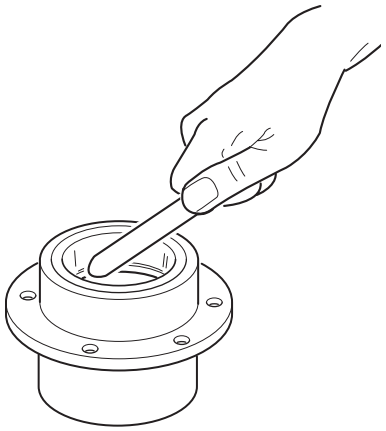
1 - Cup (outer)
2 - Bearing cage
3 - Cup (inner)

1. Remove cups.
2. Clean and inspect bearing cages for damage, nicks and burrs.



1 - Press ram
2 - Sleeve must apply pressure to back face of outer bearing cone

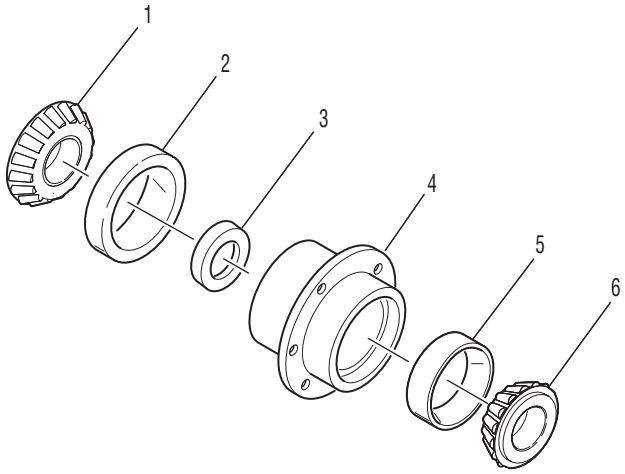
3. Install inner and outer pinion bearing cups. Use a press and an appropriate drive sleeve. Make certain bearing cup is evenly and firmly seated.
4. Seat cups securely to shoulder. Check clearance between cup and bearing cage. Must be less than .001".



Adjust Pinion Bearing Preload

Trial Buildup

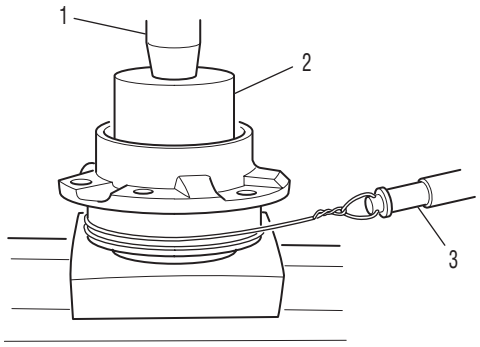
1. Assemble pinion bearing cage, bearings, spacer and spacer washer (without drive pinion or oil seal). Center bearing spacer between two bearing cones. Lubricate bearing cups and cones.



1 - Bearing
2 - Cup
3 - Spacer washer
4 - Bearing spacer (variable size)
5 - Cage
6 - Cup
7 - Bearing

Note: When new gear set or pinion bearings are used, select nominal size spacer from the specification chart. If original parts are used, use spacer removed during disassembly.

2. With the bearings well lubricated, place the assembly in the press. Position sleeve so that load is applied directly to the backface of the outer bearing cone.



1 - Press ram
2 - Sleeve must apply pressure to back face of outer bearing cone
3 - Spring scale

3. Rotate pinion cage while applying press load (see chart below) to the assembly and check rolling torque. Wrap soft wire around the bearing cage, attach spring scale and pull. Preload is correct when torque required to rotate the pinion bearing cage is from 3–7 lbs. (2–3 kgs.).

Specifications for Pinion Bearing Trial Buildup Preload Test

Torque to Rotate Bearing Cage (w/o pinion seal)
10–20 lbs. in. (1.1–2.3 N•m)

Forward Axles and Rear Axles	
Spring Scale Reading	*3 - 7 lbs.* *(2 - 3 Kgs.)*
Press Loads	*18.5 - 19.5 tons* *(16.8 - 17.7 metric tons)*
Nominal Bearing Thickness spacer	*0.185”* *(4.699 mm)*

⚠ CAUTION

Read only the torque value after the bearing cage starts to rotate.

4. If necessary, adjust pinion bearing preload by changing the pinion bearing spacer. A thicker spacer will decrease preload. A thinner spacer will increase preload.

⚠ IMPORTANT

Once correct bearing preload has been established, note the spacer size used. Select a spacer 0.001” larger for use in the final pinion bearing case assembly. The larger spacer compensates for slight “growth” in the bearings which occurs when they are pressed on the pinion shank.

Do not assume that all assemblies will retain proper preload once bearing are pressed on pinion shank. FINAL PRELOAD TEST MUST BE MADE IN EVERY CASE.

Final Buildup

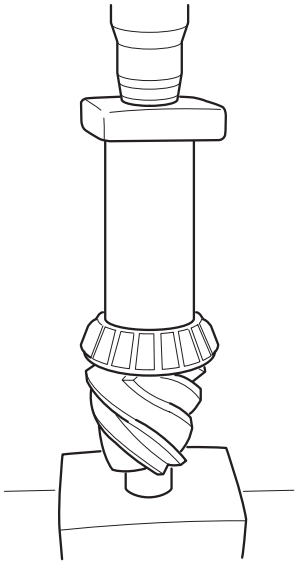
Note: On rear axles, do not install oil seal in cage until bearing preload is correctly adjusted.

⚠ IMPORTANT

After bearing cups are installed, preselect pinion bearing spacer using the "trial buildup" procedure.

Note: During pinion bearing installation, locate each part in same position that was used in "trial buildup" preload test.

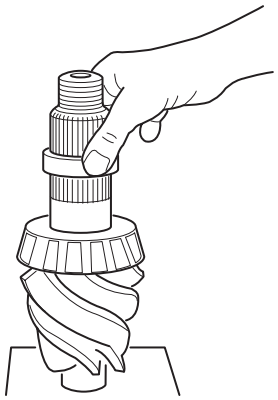
1. Press inner bearing cone on pinion.



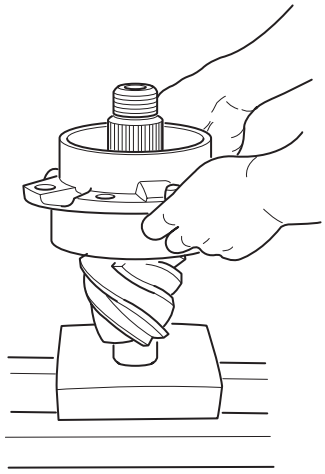
⚠ IMPORTANT

To prevent bearing damage, use suitable sleeve that only contacts inner race of bearing cone.

2. Install preselected bearing spacer.



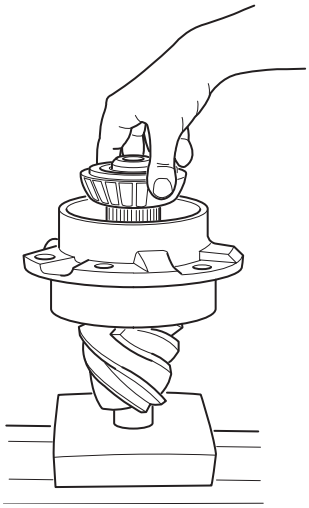
3. Install bearing cage on drive pinion.



4. Press outer bearing cone on pinion.

⚠ IMPORTANT

To prevent bearing damage, spin cage while pressing outer bearing on.



5. Apply clamp load to the pinion bearing cage assembly. Either install the yoke (or helical gear) and torque the pinion nut to specifications or use the press to simulate nut torque (see chart).

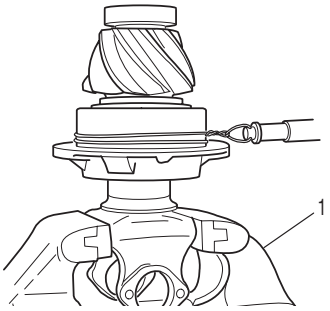
Specifications for Pinion Bearing Final Buildup Preload Test

Torque to Rotate Bearing Cage (w/o pinion seal) 15-35 lbs. in.(1.7–4.0 N•m)

	Forward Axles	***Rear Axles***
Spring Scale Reading	*5 - 12 lbs. (2 - 5 kgs.)*	
Press Loads	*18 - 21 tons (16.3 - 18 metric tons)*	
Nut Torque	*980 lbs. ft.* (1,329 N•m)*	*840 - 1,020 lbs. ft. (1,139 - 1,383 N•m)*
**Torque nut to 980 lbs. ft. (1,329 N•m), then continue tightening nut to align nut slot to nearest hole in pinion shank.*		

Vise Method

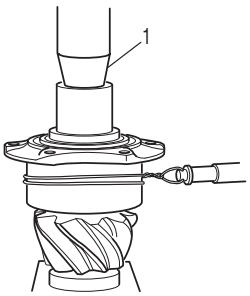
a. If the yoke and nut are used, mount the assembly in a vise, clamping yoke firmly.



1 - Vise

Press Method

a. If a press is used, position a sleeve or spacer so that load is applied directly to the backface of the outer bearing cone.



1 - Press

6. **Measure Pinion Bearing Preload:** Use a spring scale to test the assembly rolling torque. To use the spring scale, wrap flexible wire around the bearing cage, attach the scale and pull. Preload is correct when torque required to rotate the pinion bearing cage is from 5–12 lbs.

⚠ CAUTION

Read only the torque value after the bearing cage starts to rotate.

7. **Adjust Pinion Bearing Preload:** If necessary, adjust pinion bearing preload. Disassemble the pinion bearing cage as recommended in this manual and change the pinion bearing spacer. A thicker spacer will decrease preload. A thinner spacer will increase preload.

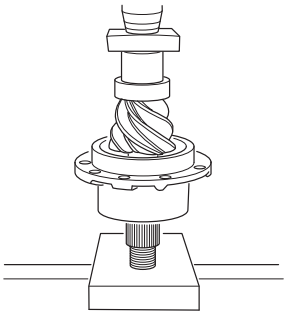
⚠ IMPORTANT

Use the correctly sized spacer. Do not use shim stock or grind spacers. These practices can lead to loss of bearing preload and gear or bearing failure.

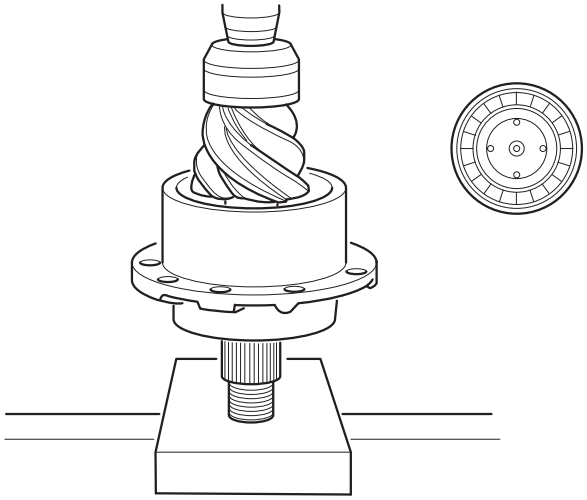
8. Press pilot bearing on pinion.

⚠ IMPORTANT

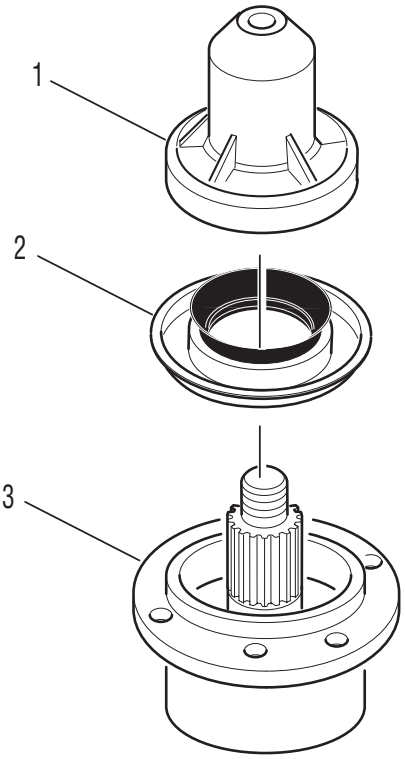
To prevent bearing damage, use suitable sleeve that only contacts the inner race of bearing con.e



9. Stake pilot bearing using staking tool. This is essential to retain the bearing.



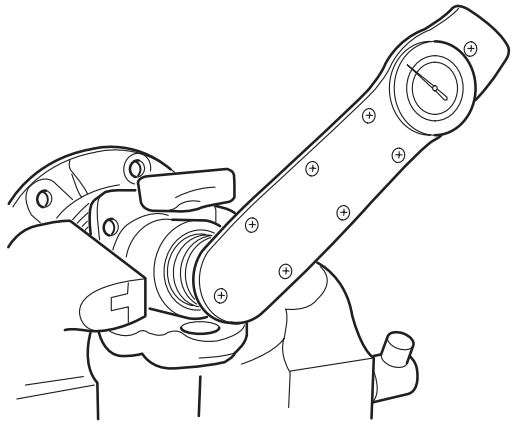
10. **Rear Axle Only:** With pinion installed and bearing preload adjustment complete, install oil seal. Use properly sized installation tool as described on page 92 to prevent distortion.



1 - Tool
2 - Seal
3 - Bearing cage

Specification for Final Pinion Bearing Preload Test ("Press-fit" Outer Pinion Bearings)		
	Nut Torque	
Axle Models	***lbs. ft.***	***N•m***
Forward Axles		
Self-Locking Nut	*840 - 1020*	*1139 - 1383*
Slotted Nut & Roll Pin	*980**	*1329**
Rear Axles	*840 - 1020*	*1139 - 1383*
** Torque nut to 980 lbs. ft.. (1329 N•m), then continue tightening nut to align nut slot to nearest hole in pinion shank.*		

11. **Rear Axle Only:** Prior to installation of yoke, make sure yoke is clean and dry.



12. Install yoke.
13. Install and tighten the nut to the specified torque: 840–1020 lbs. ft. (1140–1383 N•m).

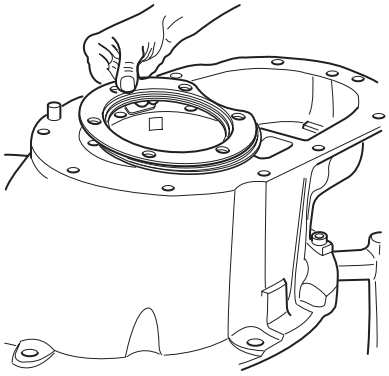
Note: Use of a torque multiplier is recommended.

TIP: If you can't get the correct torque on yoke nut, try torquing the nut with the truck wheels on the ground and with the axle shafts installed.

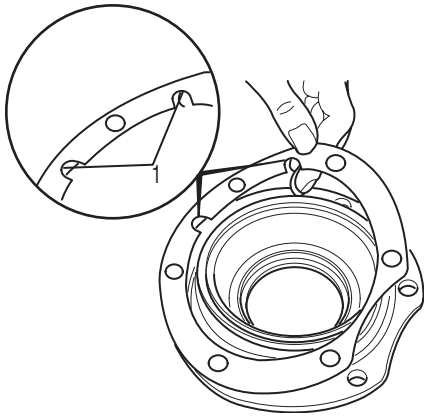
Note: Forward axle pinion helical gear and bearing: These parts are installed after pinion installation in carrier (see Install Helical Gear and Pinion Outer Support Bearing-Forward Axle Only on page 65).

Install Drive Pinion Assembly

1. **Forward Axle Only:** Place shim pack on carrier making sure holes are properly aligned. Make sure shims are flat with no kinks or bends.



2. **Rear Axle Only:** Place shim pack on carrier making sure lube holes are clear.



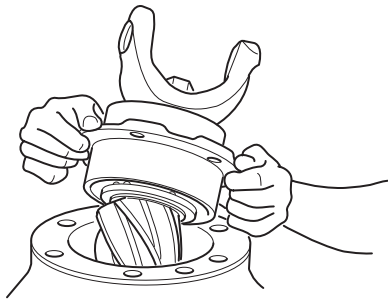
1 - Lube slots

Note: If gear set is to be reused, install same quantity and size of shims removed during disassembly. When installing a new gear set, use nominal shim pack indicated.

Nominal Shim Pack		
Axle	***in***	***mm***
Forward	*0.024*	*0.610*
Rear	*0.023*	*0.584*

3. **Forward Axle Drive Pinion Only:** Install drive pinion assembly. Install bearing cage capscrews and lock washers. Torque capscrews to 155–175 lbs. ft. (210–237 N•m).

Note: Use a dummy yoke (if available) in place of helical gear. This will result in easier disassembly and reassembly during carrier adjustments.

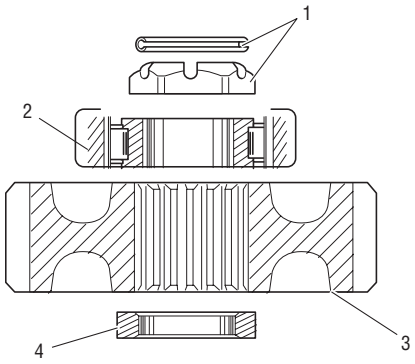


Note: Do not install cotter pin until carrier adjustments are completed.

4. **Rear Axle Drive Pinion:** Install pinion assembly. Install bearing cage capscrews and lock washers. Torque capscrews to 160–176 lbs. ft. (217–239 N•m).

Install Helical Gear and Pinion Outer Support Bearing - Forward Axle Only

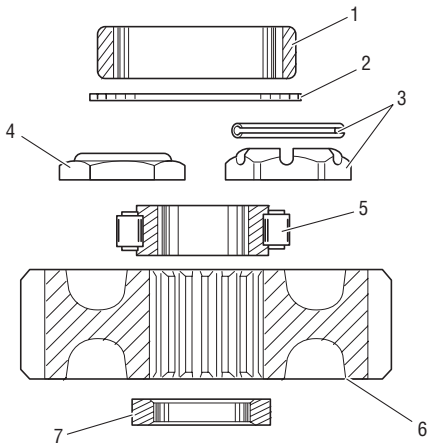
After February, 2000



One Piece Support Bearing

1 - Slotted nut and roll pin
2 - Support bearing race
3 - Helical gear
4 - Helical gear spacer

Before February, 2000

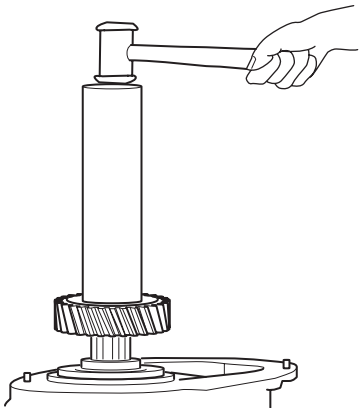


Two Piece Support Bearing

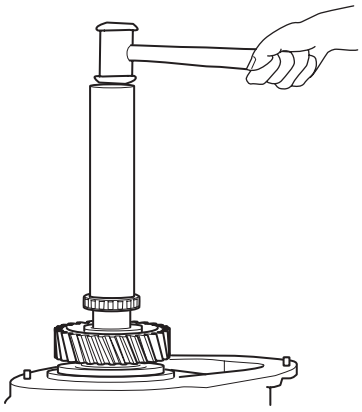
1 - Support bearing race
2 - Snap ring
3 - Slotted nut and roll pin
4 - Self locking nut
5 - Pinion outer support bearing
6 - Helical gear
7 - Helical gear spacer (D440-P, D460-P only)

Note: After differential adjustment is complete or if dummy yoke was used, remove nut and yoke. Then continue to assemble pinion as follows:

1. On D440-P and D460-P only, install helical gear spacer. Install helical gear on pinion using driver and hammer.



2. Install pinion outer support bearing using driver and hammer.

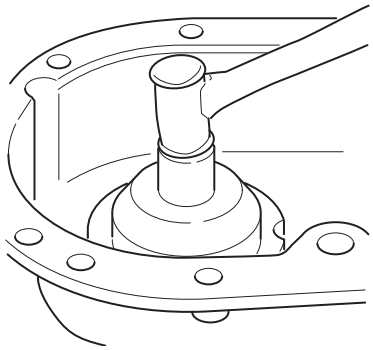


3. Install self-locking nut or slotted nut. Torque nut properly (see chart), using a suitable fixture to hold helical gear.

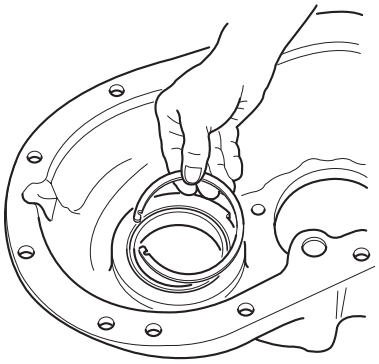
Note: On axles equipped with slotted nut and roll pin, do not install roll pin until carrier adjustments are completed.

If the power divider was built before February 2000, continue with Step 4.

4. If removed, install bearing race in power divider cover, using driver and hammer.



5. Install snap ring to secure bearing race.



⚠ WARNING

Snap ring is spring steel and may pop out. Wear safety glasses when installing.

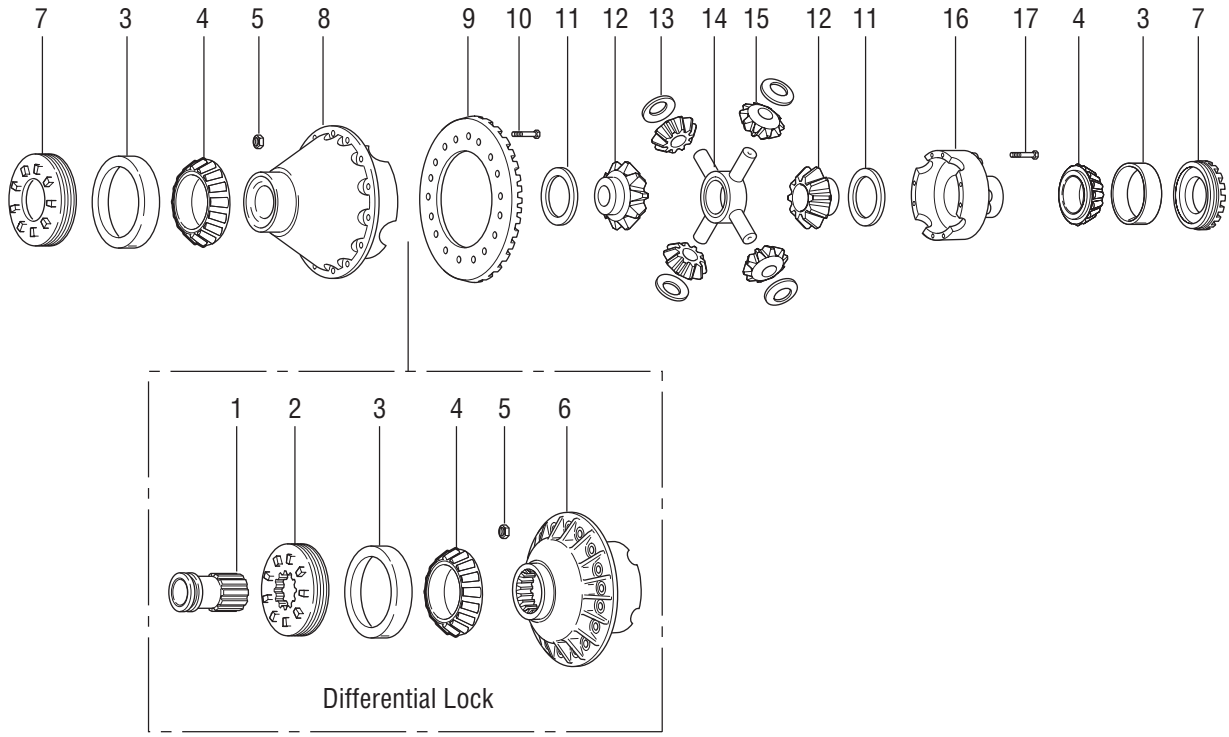
⚠ IMPORTANT

Torque to 980 lbs. ft. (1329 N•m), then continue tightening nut to align slow with the nearest hole in pinion shank. Install roll pin.

Torque Chart		
Pinion Self-Locking Nut		
Size	***lbs. ft.***	***N•m***
1-3/4 - 12	*840 - 1020*	*1139 - 1383*
Pinion Slotted Nut and Roll Pin		
Size	***lbs. ft.***	***N•m***
1-3/4 - 12	*980**	*1329**
** Torque nut to 980 lbs. ft. (1,329 N•m), then continue tightening nut to align nut slot to nearest hole in pinion shank.*		

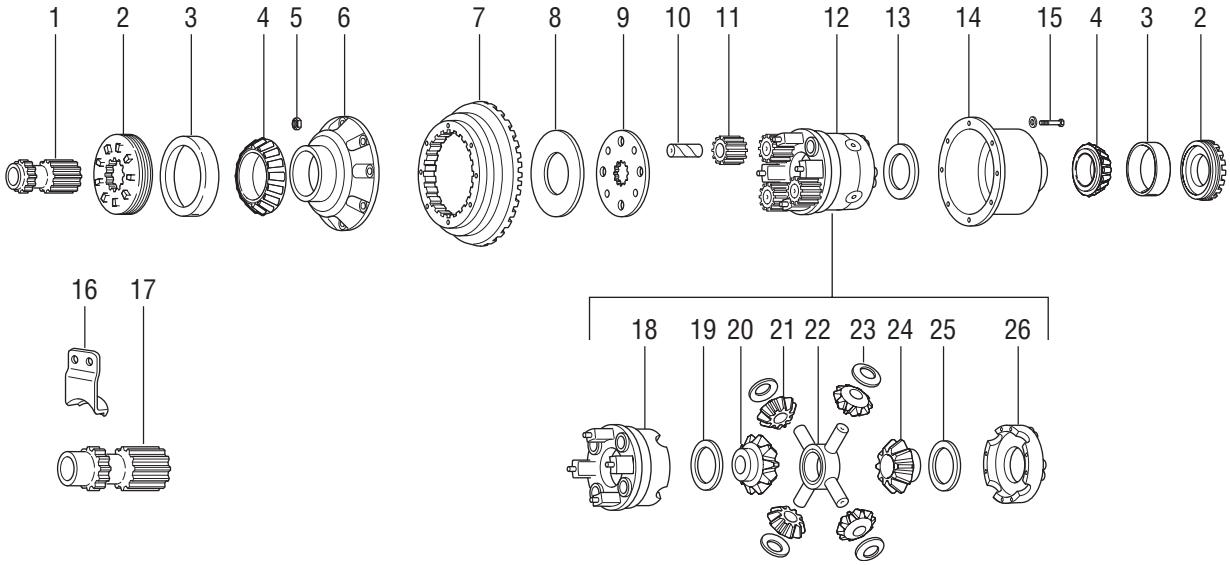
Wheel Differential Assembly - Parts Exploded View

Single Reduction Differential



1 - Sliding clutch
2 - Diff. lock differential bearing adjuster
3 - Differential bearing cup
4 - Differential bearing cone
5 - Nut (ring gear)
6 - Diff. lock differential case (flanged half)
7 - Differential bearing adjuster
8 - Differential case flange half
9 - Ring gear
10 - Bolt
11 - Side gear thrust gear
12 - Differential side gear
13 - Side pinion thrust washer
14 - Spider
15 - Side pinion
16 - Differential case (plain half)
17 - Differential case capscrew

Planetary and 2 - Speed Differential



1 - Sliding clutch (dual range only)
2 - Differential bearing adjuster
3 - Differential bearing cup
4 - Differential bearing cone
5 - Ring gear nut
6 - Gear support case
7 - Ring gear
8 - Thrust washer
9 - High speed clutch plate
10 - Idler pinion pin
11 - Idler pinion
12 - Differential assembly
13 - Thrust washer
14 - Gear support case
15 - Ring gear bolt and washer
16 - Retainer
17 - Sun gear
18 - Differential case with pins
19 - Side gear thrust washer
20 - Differential side gear
21 - Side pinion
22 - Spider
23 - Side pinion thrust washer
24 - Plain differential case

Disassemble, Overhaul and Assemble Wheel Differential (Forward and Rear Axles)

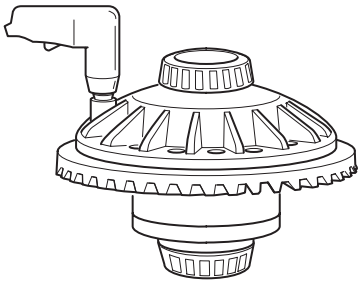
For Single Reduction Differential Case
Disassemble Wheel Differential

Note: For Dual Reduction Differential Case see page 73.

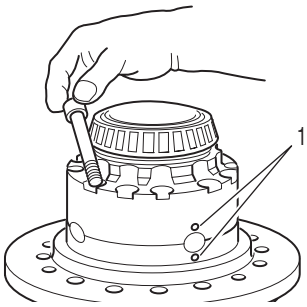
⚠ IMPORTANT

During following procedure, place differential assembly on malleable surface to prevent damage when ring gear falls off its mounting position.

1. Remove nuts and bolts fastening ring gear to differential cases, allowing gear to fall free. If gear does not fall, tap outer diameter with soft mallet to loosen.

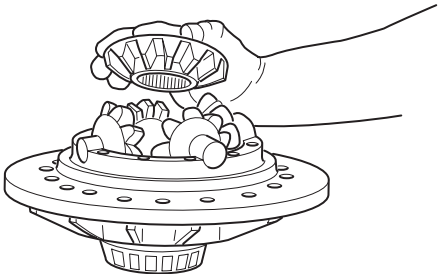


2. Punch mark differential cases for correct location during reassembly. Remove capscrews and lift off plain differential case half.

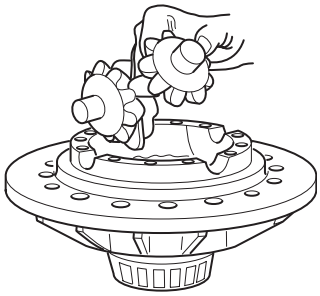


1 - Punch marks

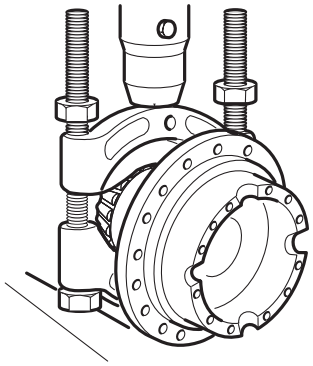
3. Lift out side gear and thrust washer.



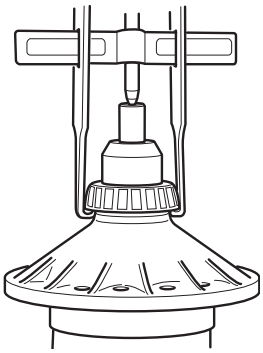
4. Lift out spider, side pinions and thrust washers.



5. Remove remaining side gear and thrust washer.
6. Remove bearing cones from case halves using suitable puller.
7. Remove bearing cone from plain case half in two steps:
   a. Mount puller vertically to split bearing. This action will start moving bearing off case.



   b. Mount puller horizontally to remove cone.



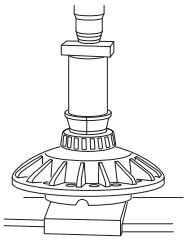
8. Remove bearing cone from flanged case half using suitable puller.

Overhaul and Assemble Wheel Differential

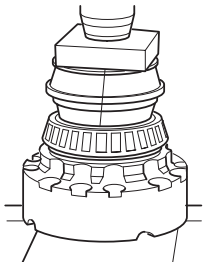
⚠ IMPORTANT

To prevent bearing damage, use suitable sleeve that only contacts the inner race of the cone. A used bearing race would be a suitable tool. This tool should have a slit cut if the ID is the same as the flange OD.

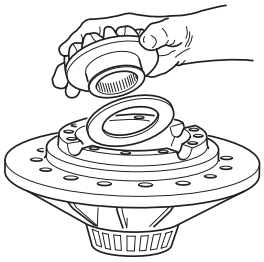
1. Press new flange half bearing cones on differential case halves.



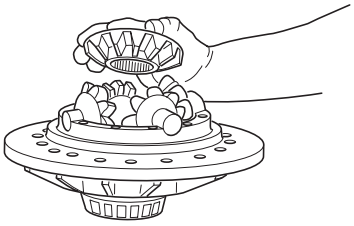
2. Press new plain half bearing cones on differential case halves.



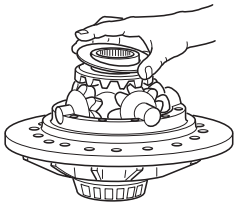
3. Place thrust washer and side gear in flanged differential case.



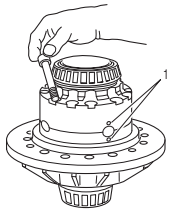
4. Lubricate all differential parts.
5. Assemble side pinion and thrust washers on spider. Place this assembly in flanged differential case. Rotate gears and check for proper mesh.



6. Place side gear and thrust washer on side pinions.



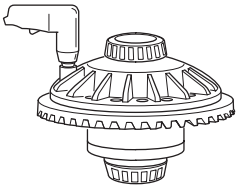
7. Align punch marks and install plain case half. Install capscrews and tighten. See Torque Chart on page 106. Check differential for free rotation by turning side gear hub.



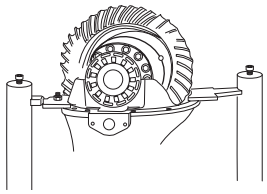
1 - Punch marks

8. Install ring gear. Secure with bolts and nuts. Torque nuts to 180-220 lbs. ft. (224-298 N•m)

Note: Flange half differential cases were redesigned starting with production axles built in January 1997. New style ring gear bolts are also required with the new style flange case, the torque specification for this bolt is different than the old 126219 bolt.

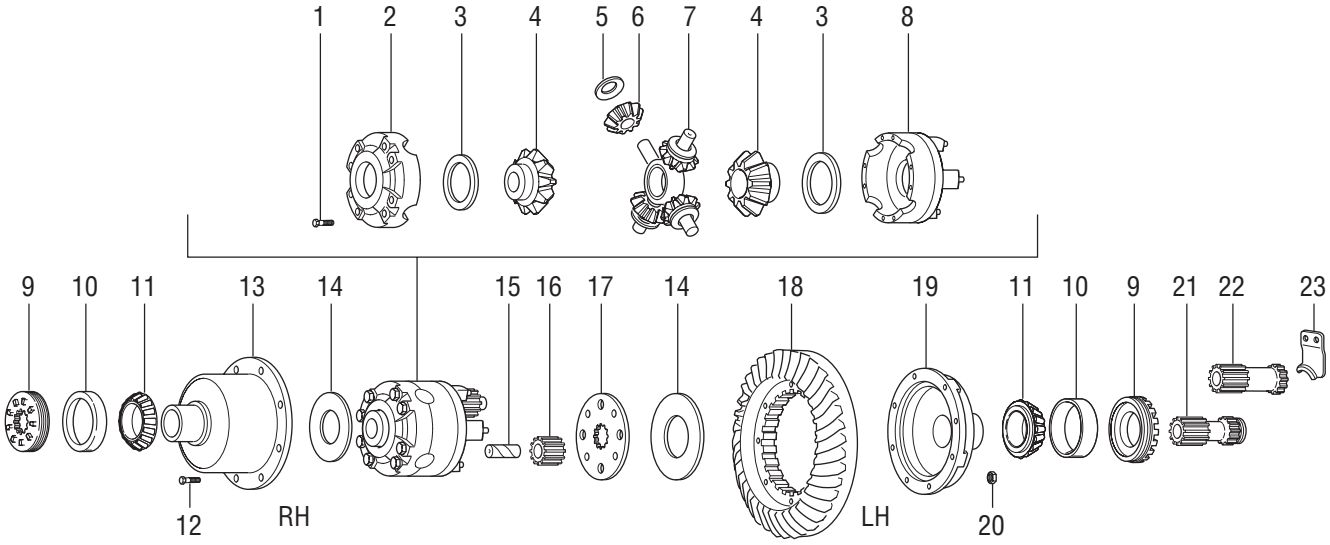


9. Lower assembled differential assembly into the carrier using a hoist and a strap. Be careful not to damage the differential bearings lowering the assembly.
10. Install the bearing cup and bearing adjuster to the flange half side first.



11. Install the bearing cup and bearing adjuster to the plain half side. Use a long screwdriver or bar to lift the differential up while installing the cup and bearing adjuster.

Planetary and 2-Speed Models (Forward and Rear Axles)

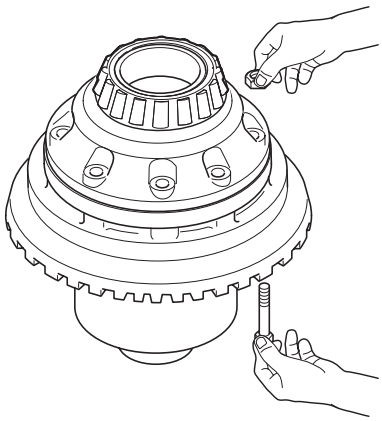


1 - Differential case capscrew
2 - Differential case (plain)
3 - Side gear thrust washer
4 - Differential side gear
5 - Side pinion thrust washer
6 - Side pinion
7 - Spider
8 - Differential case with pins
9 - Differential bearing adjuster
10 - Differential bearing cup
11 - Differential bearing cone
12 - Ring gear bolt
13 - Gear support case (large)
14 - Support case thrust washer
15 - Idler pinion pin
16 - Idler pinion
17 - High speed clutch plate
18 - Ring gear
19 - Gear support case (small)
20 - Ring gear nut
21 - Sliding clutch (dual range axles)
22 - Sun gear
23 - Sun gear retainer

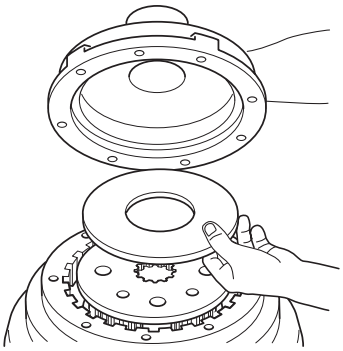
Disassemble Dual Reduction Differential Case

Note: For Single Reduction Differential Case see page 68.

1. Remove nuts and bolts fastening ring gear and support cases.



2. Remove small support case and thrust washer.

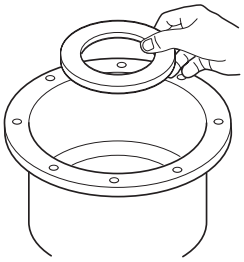


3. Remove ring gear.

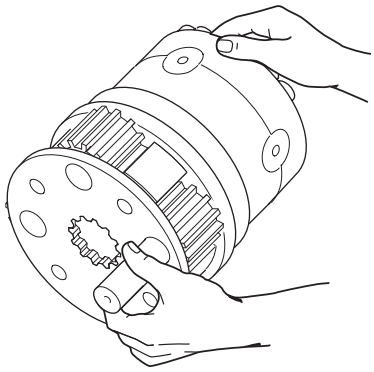
Note: A soft-faced hammer or mallet may be required to dislodge gear from its mounting.

4. To remove differential assembly, place support case assembly on a bench or on the floor. Position case on its side, then slowly roll the case and slide differential assembly out of the case.

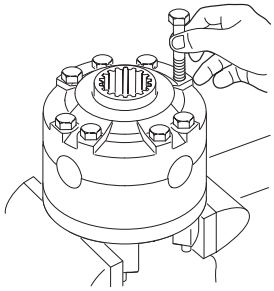
5. Remove thrust washer from support case.



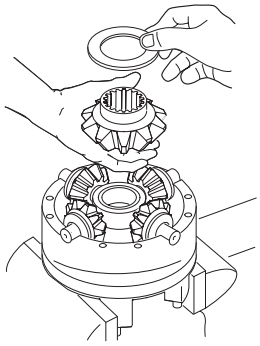
6. Invert differential assembly to remove idler pins, then remove idler pinions.



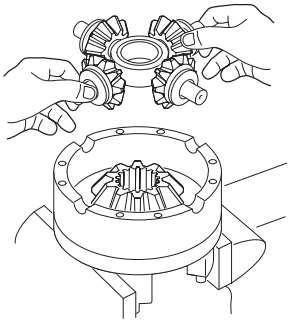
7. Punch mark differential cases for correct location in reassembly. Remove capscrews and separate case halves.



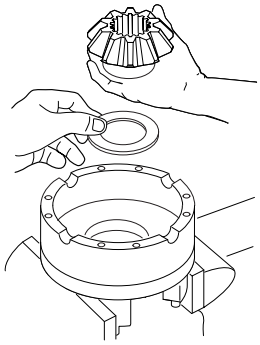
8. Lift out thrust washer and side gear.



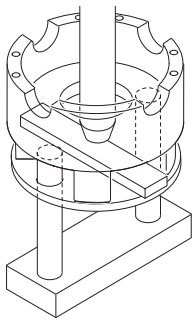
9. Lift out spider, side pinions and side thrust washers.



10. Remove inner side gear and thrust washer.



11. First, try to lift off high-speed clutch plate by hand. If it cannot be removed easily, press off plate as follows:

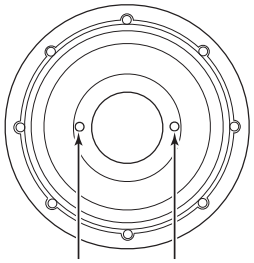


   a. Insert properly sized adapters (round metal stock) into two idler pin holes and invert the case assembly in a press. The clutch plate should be down. The adapter length should provide space for removal of the plate.

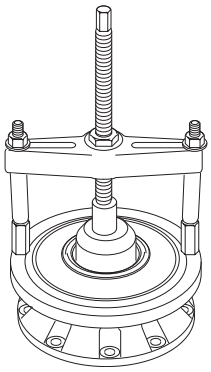
   b. Use bar stock to block the center hole in the clutch plate and press against it with the press ram.

   c. Continue to press until the plate breaks loose from the plate dowel pins.

12. Remove bearing cones from support cases using suitable puller.



Note: Holes are provided in case to enable removal of bearing cone with a pin punch. Tap alternately through each hole until cone is removed.



⚠ WARNING

When using a drift, punch or similar tool, wear safety glasses.

Assemble Dual Reduction Differential Case

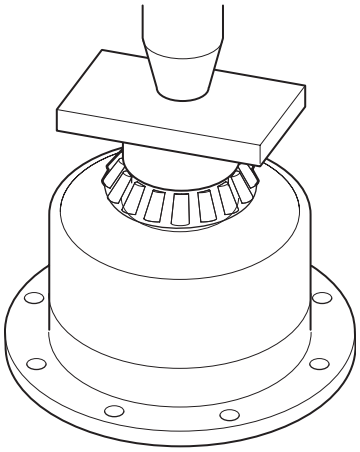
Note: Lubricate internal parts with gear lube during reassembly.

1. Press bearing cones on support cases.

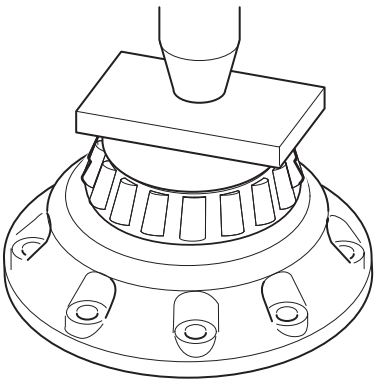
⚠ IMPORTANT

To prevent bearing cone damage, use suitable sleeve that only contacts the inner race of the cone.

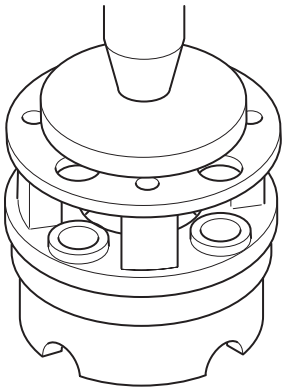
Pressing Bearing Cone on Large Support Case



Pressing Bearing Cone on Small Support Case

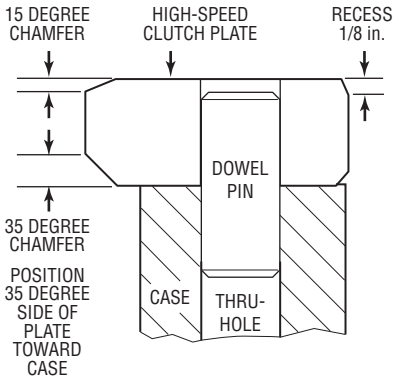


2. Position high-speed clutch plate with chamfered end of clutch teeth toward idler pinions. Press clutch plate on case.

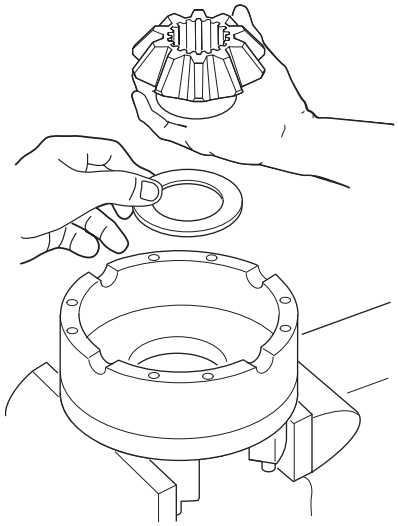


⚠ IMPORTANT

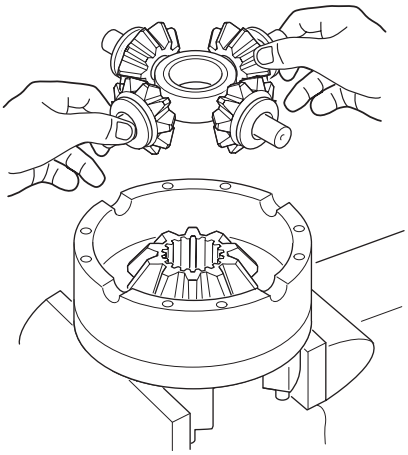
It is important that the ends of the dowel pins are recessed 1/8 inch below surface of the clutch plate. If pins extend beyond plate surface, press pins to proper depth. Don't press them in too far.



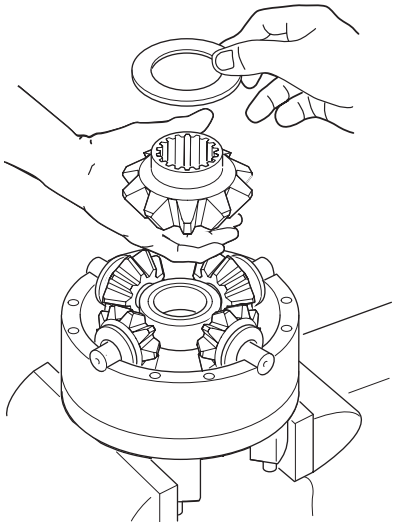
3. Place thrust washer and side gear in differential case.



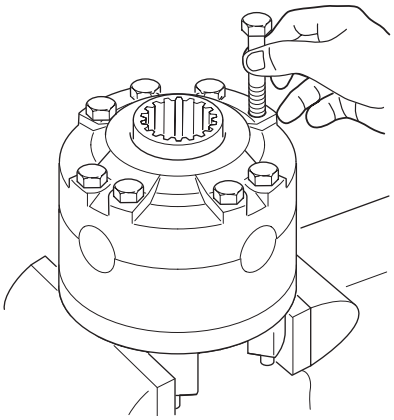
4. Assemble side pinions and thrust washers on spider. Place this assembly in differential case.



5. Place side gear and thrust washer in position on side pinions.

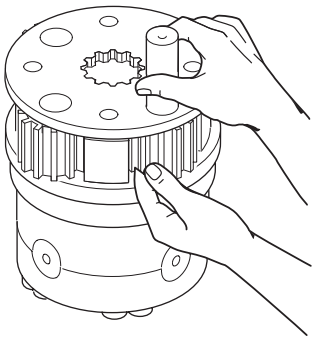


6. Align punch marks and place plain case on case (with pins). Install capscrews. Torque screws to 116-130 lbs. ft. (157-176 N•m).

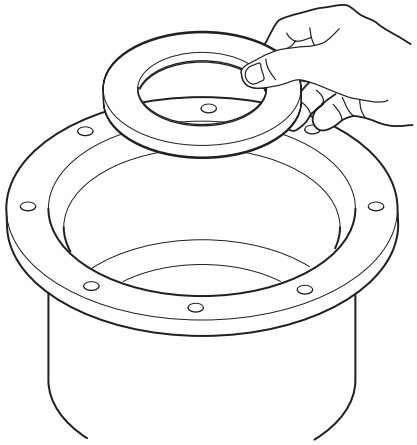


Note: Turn side gear hub to check for free differential rotation. Rotation may require up to 50 lbs. ft. (65 N•m).

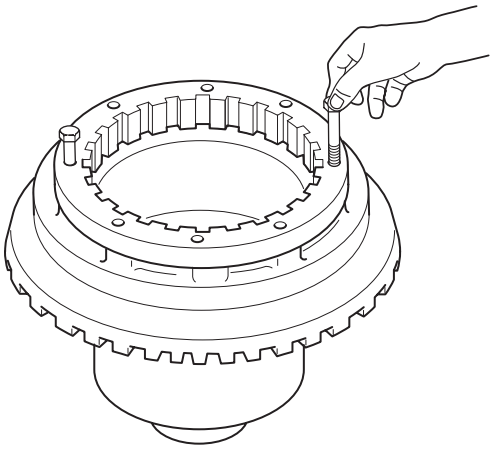
7. Install idler pins and pinions.



8. Place thrust washer in support case.



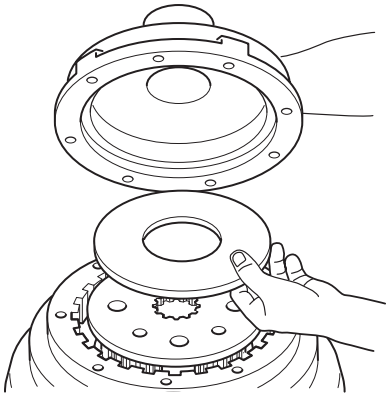
9. During installation of ring gear, temporarily use two bolts in mounting holes to assure bolt hole alignment. Place ring gear on support case, then remove two bolts.



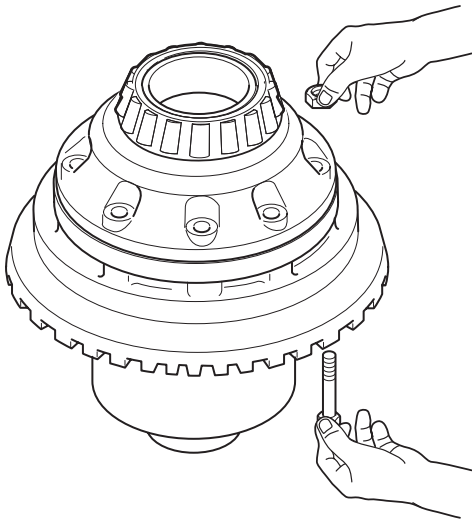
10. To install differential assembly, place support case and ring gear assembly on bench or the floor. Position case on its side. Carefully lift and slide differential assembly into case. Engage idler pinions with ring gear teeth to complete the installation.

Note: During differential installation, be sure thrust washer stays in its proper mounting position.

11. Install thrust washer and small support case over differential assembly.



12. Carefully install ring gear bolts, making certain flat on bolt head is seated against the outside diameter of the support case. Install nuts and torque to 110-130 lbs. ft. (149-176 N•m).

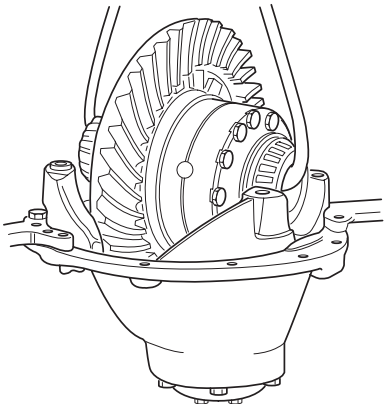


Note: Temporarily install sliding clutch (or sun gear) and check planetary for free rotation.

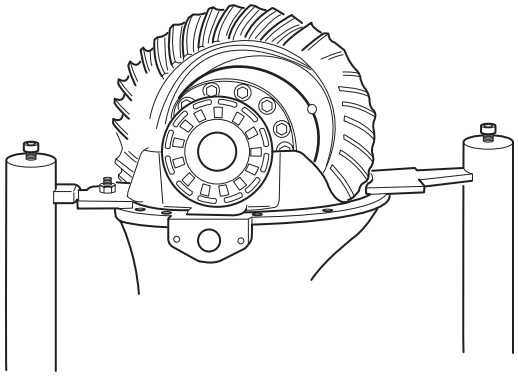
Install Differential–Forward and Rear Axles

Note: Lubricate bearings during the following assembly procedures.

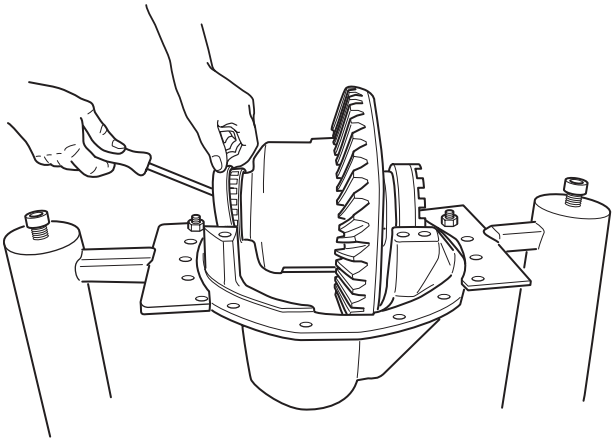
1. Place ring gear and differential assembly in carrier. Carefully lower the assembly until bearing cones rest on carrier.



2. Install bearing cup and bearing adjuster to the flange half side first.



3. Lubricate the differential bearings. Install bearing cup and bearing adjuster to the plain half side. Use a long screwdriver or bar to lift the differential up while installing the cup and bearing adjuster.

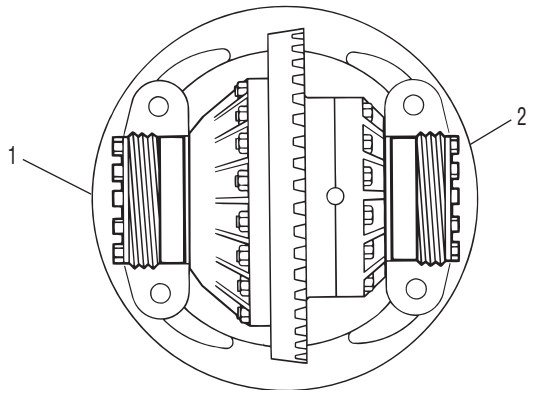


4. With bearing adjusters and cups assembled to carrier, the carrier assembly is now ready for adjustment of bearing preload, ring gear backlash and gear tooth contact (see page 79).

Measure and Adjust Carrier Assembly

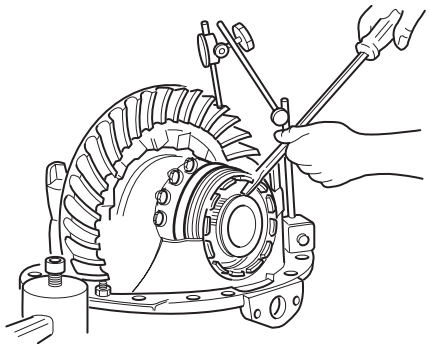
Adjust Backlash and Preload

1. Turn the flange half bearing adjuster in until the ring gear contacts the pinion (zero backlash) then back the adjuster out two notches of the adjuster lugs.

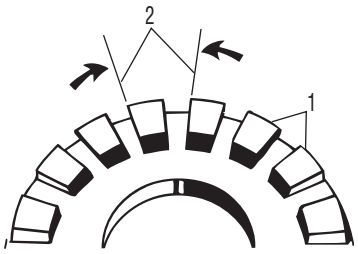


1 - Flange half
2 - Plain half

2. Tighten the plain half adjuster until the bearing cup just starts to turn, this is a zero bearing preload.



3. Tighten the plain half adjuster two lug notches. Start with the notch at the top, count two notches counter-clockwise on the adjuster, turn the adjuster so that the notch is facing straight up. You now have a two notch preload.



1 - Lugs
2 - One notch

4. Use a rubber mallet to make certain that both bearing adjusters are fully seated.

5. Measure backlash. Make sure it is within specification of .006"–.018".

   TIP: To give yourself room to adjust contact pattern, set it between .010"–.012".

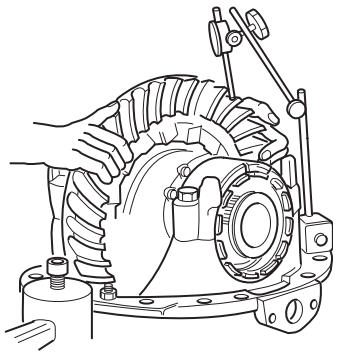
Change Backlash Setting

If you have too much backlash the ring gear needs to move closer to the pinion. Back off the plain half adjuster, count the number of notches you back it off, each notch equals about .003" of backlash.

⚠ IMPORTANT

In order to maintain the differential bearing preload you will need to turn the flange half bearing adjuster the same amount in the same direction. If you need more backlash reverse this procedure.

1. Install carrier bearings caps and torque carrier cap bolts to 370–430 lbs. ft. (501–583 N•m)
2. **Recheck backlash:** if the bearing adjusters were not in straight or fully seated the backlash will change.
   a. **Used Gearing:** Reset to backlash recorded before disassembly.
   b. **New Gearing:** Backlash should be between 0.006 and 0.018".

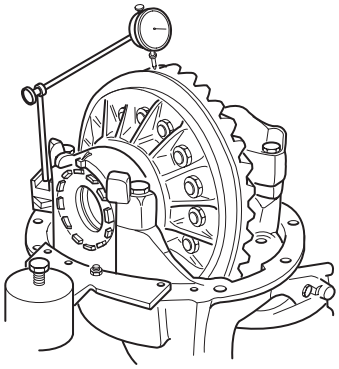


3. Check ring gear tooth contact pattern. Paint ring gear teeth and check tooth contact pattern. Correct tooth patterns. Checking and adjusting procedures are on page 80.
4. Install bearing adjuster cotter pins.
5. Install retainer.

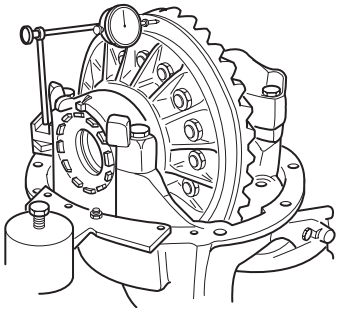
Measure Ring Gear Runout

Measure Ring Gear Total

1. Measure ring gear total radial runout. (Indicator reading should not exceed .010").

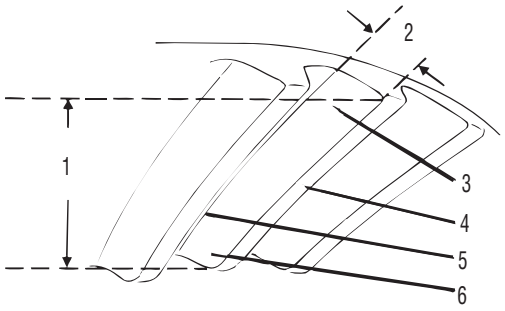


2. Measure ring gear total backface runout (Indicator reading should not exceed .010").



Adjust Tooth Contact Pattern

Adjust Ring and Pinion Tooth Contact Pattern



1 - Face width
2 - Tooth depth
3 - Heel
4 - Top land
5 - Root
6 - Toe

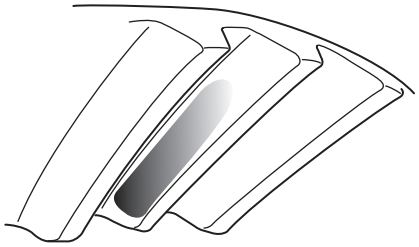
Note: Rear axle gearing is shown in the following instructions. Correct tooth contact patterns and adjustments are the same for forward and rear axles.

1. Identify if new or used gearing.
2. Check tooth contact pattern (new or used gearing).

New Gearing - Correct Pattern

Paint six ring gear teeth 180° apart with marking compound and roll the gear to obtain a contact pattern. The correct pattern is slightly below center on the ring gear tooth with lengthwise contact up off the toe. The length of the pattern in an unloaded condition is approximately one-half to two-thirds of the ring gear tooth in most models and ratios.

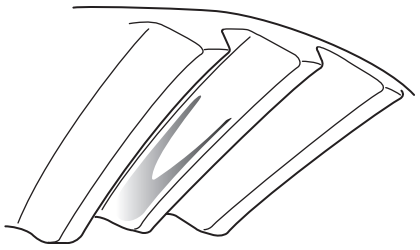
The pattern could vary in length and should cover 1/2 tooth or more (face width). The pattern should be evenly centered between tooth top land and root and should be up off the tooth toe.



Used Gearing - Correct Pattern

Used gearing will not usually display the square, even contact pattern found in new gear sets. The gear will normally have a “pocket” at the heal end of the gear tooth. The more use a gear has had, the more the line becomes the dominant characteristic of the pattern.

Adjust used gear sets to display the same contact pattern observed before disassembly. A correct pattern is up off the toe and centers evenly along the face width between the top land and root. Otherwise, the length and shape of the pattern are highly variable and is considered acceptable as long as it does not run off the tooth at any point.



Pattern along the face width could be longer

Adjust Contact Pattern

If necessary, adjust the contact pattern by moving the ring gear and drive pinion.

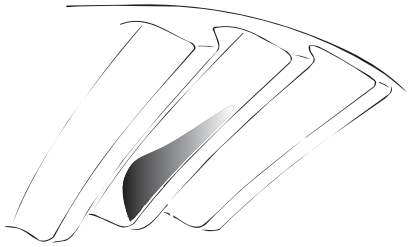
- Ring gear position controls the backlash. This adjustment moves the contact pattern along the face width of the gear tooth.
- Pinion position is determined by the size of the pinion bearing cage shim pack. It controls contact on the tooth depth of the gear tooth.

These adjustments are interrelated. As a result, they must be considered together even though the pattern is altered by two distinct operations. When making adjustments, first adjust the pinion, then the backlash. Continue this sequence until the pattern is satisfactory.

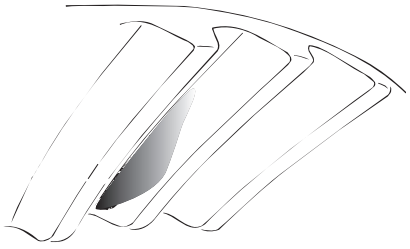
Adjust Pinion Position
If the gear pattern shows incorrect tooth depth contact, change drive pinion position by altering the shim pack. Used gears should achieve proper contact with the same shims removed from the axle at disassembly.

Note: Check ring gear backlash after each shim change and adjust if necessary to maintain the 0.006" to 0.018" specifications.

If the pattern is too close to the top land of the gear tooth, remove pinion shims. Move pinion toward the ring gear.

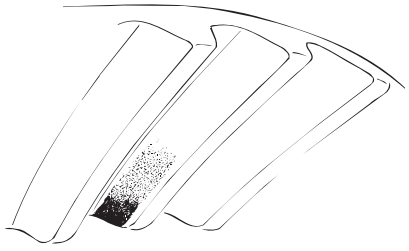


If the pattern is too close to the root of the gear tooth, add pinion shims. Move pinion away from the ring gear.



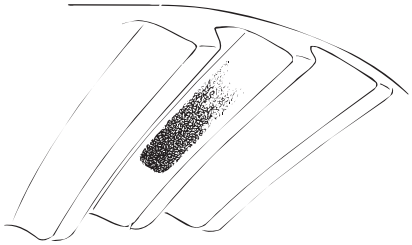
Adjust Ring Gear Position (Backlash)
If the gear pattern shows incorrect face width contact, change backlash by adjusting the ring gear.

If the pattern is too close to the edge of the tooth toe, move the ring gear away from the pinion to increase backlash



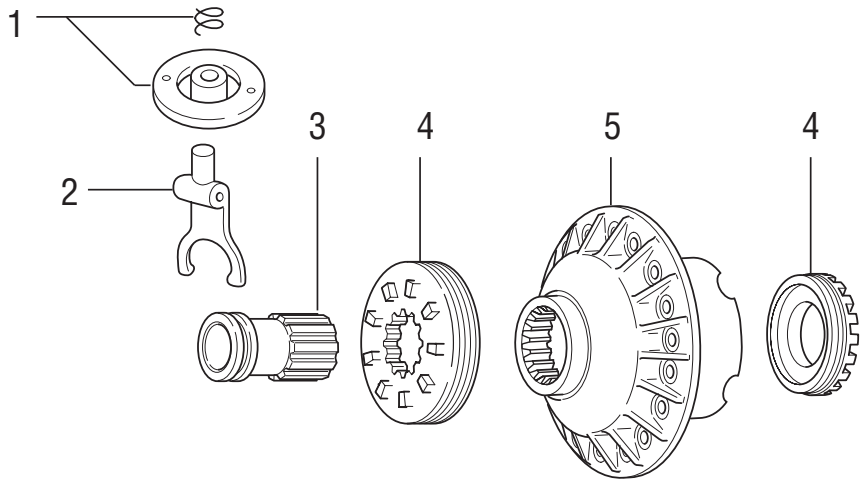
1. Loosen the bearing adjuster on the teeth side of the ring gear several notches.
2. Loosen the opposite adjuster one notch.
3. Return to adjuster on teeth side of ring gear and tighten adjuster until it contacts the bearing cup.
4. Continue tightening the same adjuster 2 or 3 notches and recheck backlash.

   If the pattern is concentrated at the heel (too far up the tooth), move the ring gear toward the pinion to decrease backlash.



5. Loosen the bearing adjuster on the teeth side of the ring gear several notches.
6. Tighten the opposite adjuster one notch.
7. Return to adjuster on teeth side of ring gear and tighten adjuster until it contacts the bearing cup.
8. Continue tightening the same adjuster 2 or 3 notches and recheck backlash.

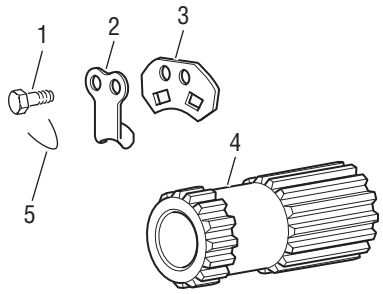
Wheel Differential Lock - Parts Exploded View



1 - Shift fork seal and spring assembly
2 - Shift fork and roller assembly
3 - Sliding clutch
4 - Differential bearing adjuster
5 - Differential case (flanged half)

Install and Adjust Wheel Differential Lock, Dual Range Shifters

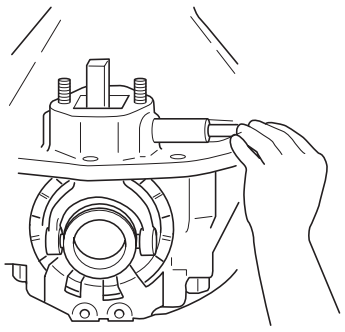
1. **For planetary double reduction axles** (on backface side of ring gear), install sun gear and retainer, then install capscrews that fasten both retainer and adjuster lock capscrews. Tighten screws to correct torque (see chart), and lockwire all capscrews.



Planetary Double Reduction Axle

1 - Capscrew
2 - Sun gear retainer
3 - Bearing adjuster
4 - Sun gear
5 - Lock wire

2. **For dual range axles and differential lock:** Position shift fork in carrier opening, then install sliding clutch
3. With clutch installed, engage shift fork yoke with clutch collar. Then install shift fork shaft. Install expansion plugs to seal openings.



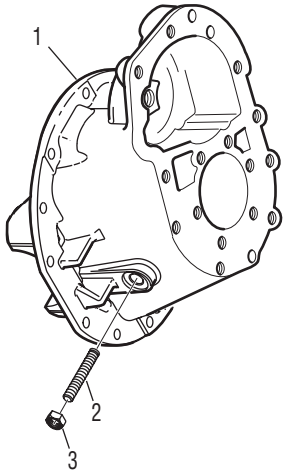
Installing Shift Fork Shaft

4. Install shift unit seal and spring.

Torque Chart Cap			
Differential Bearing Capscrew Size	**Grade**	**lbs. ft.**	**N•m**
13/16-10	(8)	370 - 430	501 - 583
Bearing Adjuster Lock and Sun Gear Retainer Capscrew Size	**Grade**	**lbs. ft.**	**N•m**
5/8-11	(5)	160 - 176	216 - 238

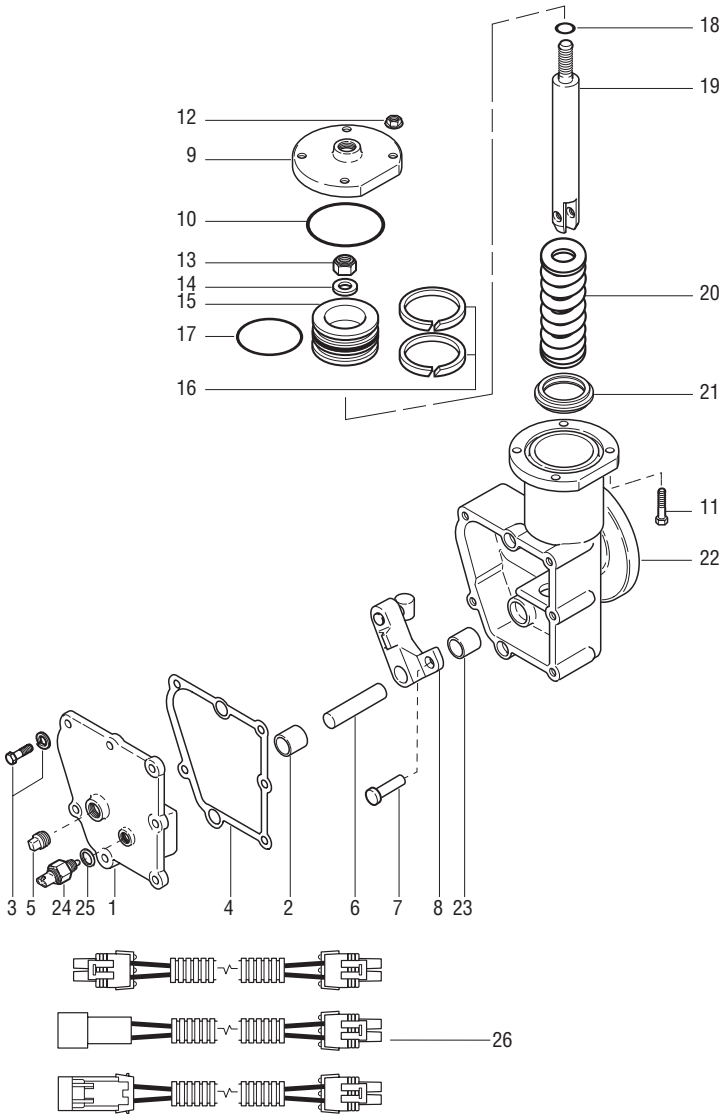
Install and Adjust Ring Gear Thrust Bolt

1. Thread thrust screw into the carrier until firm contact with the backface of the ring gear is made.
2. Loosen the thrust screw 1/4 turn to obtain the correct adjustment of .020" (.50 mm) clearance between gear face and screw. Tighten jam nut, holding thrust screw stationary with a wrench, torque jam nut 150–190. lbs. ft. (203–258 N•m).
3. Recheck to assure minimum clearance during full rotation of ring gear.



1 - D-head carrier or front carrier
2 - Thrust bolt
3 - Thrust bolt jam nut

Piston Air Shift Unit



1 - Cover assembly
2 - Cover bearing
3 - Screw and washer assembly
4 - Cover gasket
5 - Cover plug
6 - Actuating lever
7 - Clevis pin
8 - Actuating lever, pin, and block assembly
9 - Shift housing cover
10 - Seal ring
11 - Cover bolt
12 - Lock nut
13 - Lock nut
14 - Washer
15 - Piston
16 - Felt piston oiler (strip)
17 - Piston o-ring
18 - Grommet
19 - Push rod
20 - Compression spring
21 - Piston stop
22 - Housing assembly
23 - Housing bearing
24 - Switch
25 - Nylon washer
26 - Wiring harness

Air Shift Unit Replacement

Removal of Shift Unit

1. Disconnect air lines at shift unit cover.
2. Disconnect the wiring harness and remove selector switch from the housing cover.
3. Remove nuts, flat washers and piston air shift unit from the differential carrier.

Note: When shift unit is removed, provide container to catch oil that escapes from reservoir.

4. Remove shift fork seal and spring assembly.

Note: Dana Service Manual AXSM-0029 for overhaul procedures on air shift units is available.

Air Shift Unit Installation

1. Lubricate shift fork.
2. Slide shift fork seal and spring assembly over fork and seal onto the shift unit carrier studs.
3. Place shift unit on mounting studs and make certain shift fork actuating lever engages slot in shift fork.
4. Install flat washers and stud nuts.
   - Torque 55-61 lbs. ft. (74-82 N•m)

Note: When axle is installed in vehicle, fill shift unit housing to level of filler plug with SAE 10 oil [1.5 oz. (50 ml)]. Coat threads of filler plug with sealer and install plug.

5. Thread selector switch in air shift unit and reconnect wiring harness
6. Connect air lines to shift unit cover.

Air Shift Unit Overhaul

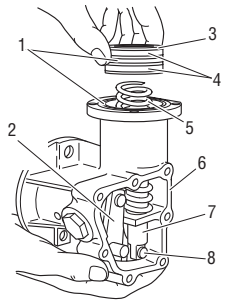
Disassemble Unit

1. Remove capscrews, lock washers, cover and gasket from housing. Drain lubricant.
2. Remove bolts, lock nuts, cover at piston end of housing. Remove o-ring.

⚠ CAUTION

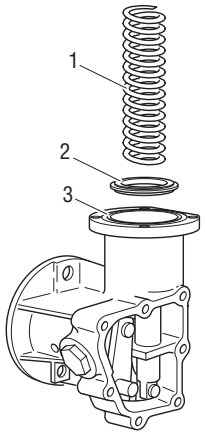
During the following procedure, the piston will pop out of housing under spring pressure. Exercise caution to prevent possible injury.

3. Remove lock nut, flat washer, and piston from push rod. Remove o-ring and felt oilers from piston.



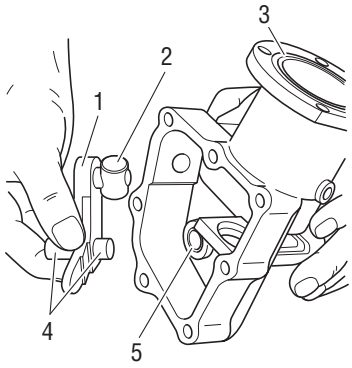
1 - O-ring
2 - Actuating lever assembly
3 - Piston
4 - Felt oilers
5 - Compression spring
6 - Shift unit housing
7 - Piston rod
8 - Clevis pin

4. Remove compression spring and piston stop from bore of shift unit housing.



1 - Compression spring
2 - Piston
3 - O-ring

5. Remove clevis pin, then remove push rod from shift unit housing. Remove o-ring from push rod.
6. Remove actuating lever and pin from shift unit housing. Do not disassemble actuating lever.



1- Actuating lever
2 - Shift fork swivel pin
3 - O-ring
4 - Actuating lever pin
5 - Bearing

Parts Inspection

Shift Fork Seal: Inspect shift fork seal for defects and tight fit on shift fork. A spring is used to assure a closer fit of seal around shift fork. If this spring is not present on axle being serviced, install one when reassembling unit.

O-rings, Felt Oilers and Gasket: Replace o-rings, felt oilers and cover gasket when piston air shift unit is disassembled for repair.

Compression Spring: Inspect spring for distortion, cracks or other visual defects. Replace a faulty spring.

Actuating Lever and Pins: Inspect lever pins and bearings for worn or grooved condition. Inspect actuating lever and push rod for worn or elongated holes at point where they are connected. Replace faulty parts.

Piston: Inspect piston friction surface for worn, grooved or damaged condition which will affect the piston movement in cylinder. Replace a faulty piston.

Assemble Unit

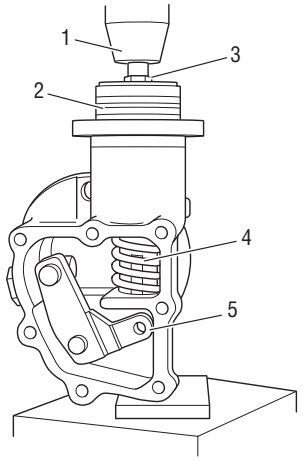
Note: Prior to assembly, the piston felt oilers should be soaked in SAE 10 oil for one hour. Lubricate o-rings with a high-viscosity silicone oil or barium grease o-ring lubricant.

1. Assemble pin to actuating lever and install this assembly in shift lever unit housing.
2. Assemble o-ring and piston to push rod and fasten with flat washer and lock nut. Tighten nut to a torque of 120-150 lbs. in. (14-17 N•m). Install felt oilers and o-ring in piston.

⚠ CAUTION

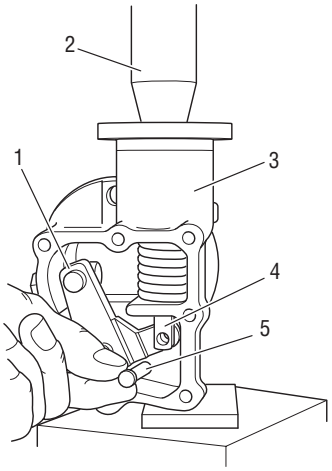
During the following procedure using a press, make certain components are properly aligned in press to prevent possible personal injury or damage to parts.

3. Insert piston stop and compression spring in shift unit housing. Place piston and push rod assembly in housing. Position housing assembly in arbor press.



1 - Press
2 - Piston
3 - Piston lock nut
4 - Compression spring
5 - Actuating lever assembly

4. Apply pressure to piston until actuating lever is in alignment with push rod end. Install clevis pin. Release press.



1 - Actuating lever assembly
2 - Press
3 - Shift unit housing
4 - Push rod
5 - Clevis pin

5. Place cover gasket in position on shift unit housing then install cover and bearing assembly and fasten with capscrew and lock washers. If necessary, use a sealer on threads of capscrews to prevent any leaking. Tighten screws to a torque of 90-110 lbs. in. (10-12 N•m).
6. Place o-ring in groove of shift unit housing, then install housing cover and secure with bolts and lock nuts. Tighten lock nuts evenly to a torque of 108-132 lbs. in. (12-15 N•m).
7. Fill shift unit with SAE 10 oil or automatic transmission fluid (see Lubrication) when axle is installed in vehicle.

Lubrication

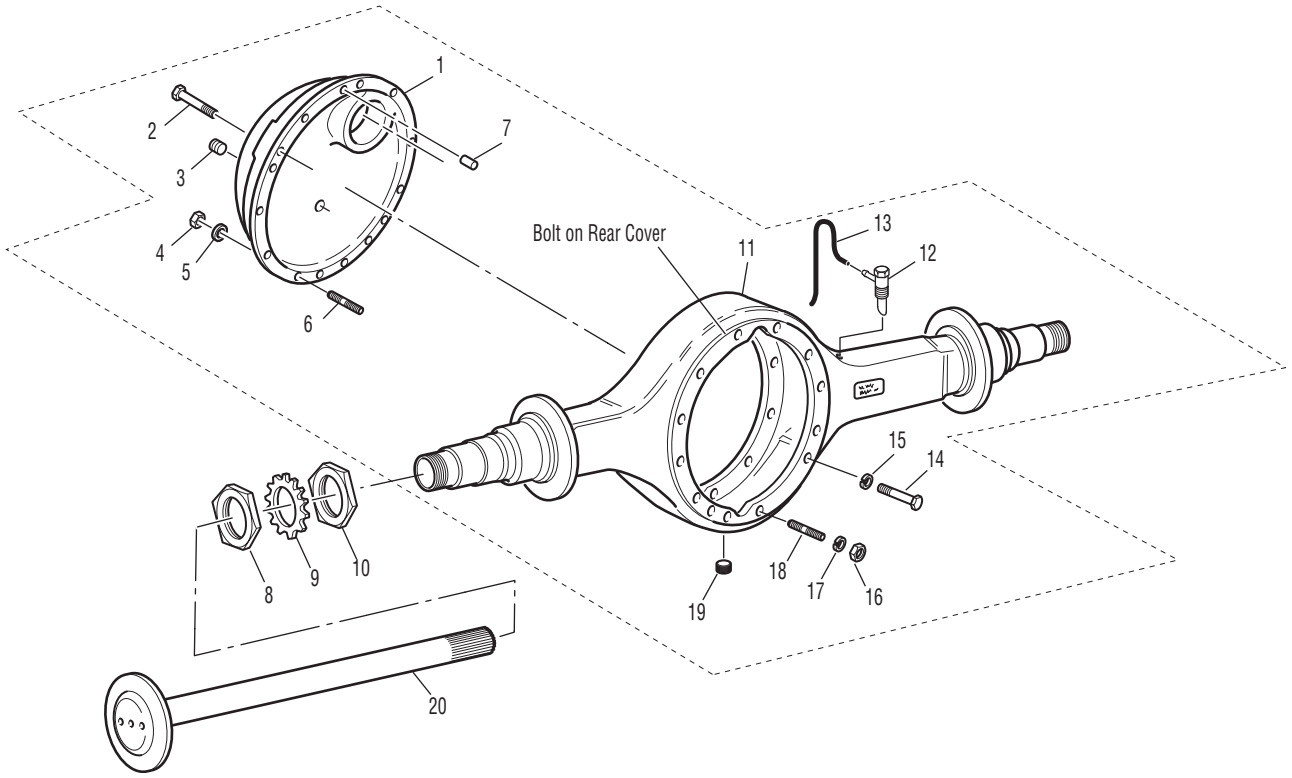
Lubricant: Use SAE 10 motor oil* for temperature above 0°F (–18°C). For temperatures below 0°F (–18°C), mix three parts of SAE 10 motor oil with one part of kerosene. This cold weather mixture can be safely used up to 32°F (0°C).

Note: Commercially available automatic transmission fluid may be used in place of SAE 10 motor oil. Automatic transmission fluid can be used for all temperatures. Do not mix kerosene with automatic transmission fluid.

Lubricant Check and Level: Each 20,000 miles or six months, remove pipe plug in shift unit housing cover to check lubricant level. Lube should be level with bottom of filler hole [1.5 oz. (50 ml)].

Lubricant Change: At least once a year remove shift unit housing cover and drain old lubricant. Wash parts thoroughly and air dry. Reinstall cover. Remove pipe plug in cover. Fill through pipe plug opening until lube is level with bottom of filler hole.

Housing and Rear Cover Assembly - Parts Exploded View



1 - Rear cover
2 - Rear cover capscrew
3 - Fill plug
4 - Rear cover nut
5 - Lock washer
6 - Stud
7 - Dowel
8 - Jam nut - outer
9 - Locking ring
10 - Jam nut (inner)
11 - Axle housing
12 - Breather
13 - Breather hose
14 - Carrier capscrew
15 - Lock washer
16 - Nut
17 - Lock washer
18 - Stud
19 - Drain plug
20 - Axle shaft

Seals

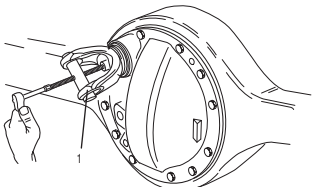
Replace Seal

Dana strongly recommends using seal drivers when installing new seals. Use the proper driver to make sure that the seal is square and installed to the proper depth.

⚠ CAUTION

Oil seals can be easily damaged prior to installation. Use care when handling the new seal to prevent damage or contamination. Leave the seal in its package until installation. On new yokes, leave the protector on the yoke until it is installed on the shaft to prevent damage or contamination.

1. Inspect axle end-play at the yoke (see page 10). Service if beyond specified limit.
2. Remove the old yoke using appropriate tool. A yoke puller tool may be made from the center section of most gear puller tools, or may be purchased from your local tool distributor.



1 - Yoke puller tool

3. Remove seal. Use care when removing the old seal to prevent damage to the housing seal bore.
4. Inspect the seal bore area for any damage (nicks, gouges, corrosion). Carefully remove any slight damage with a crocus cloth. Clean the bore area to remove any loose debris.

⚠ CAUTION

Do not use any silicone or permatex-type bore sealant with this seal.

5. Remove the new seal from its package and install with the proper driver:

Service kit #217590

D-Input-Use driver #210749 with inert 210750 only

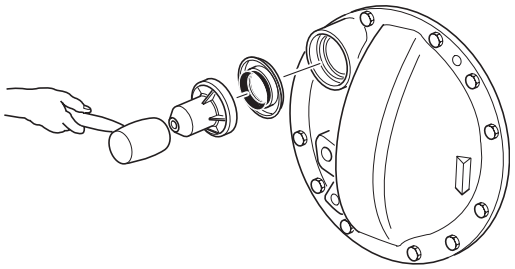
D-Output-Use insert #210751

R-Pinion-Use driver #210749 only

⚠ WARNING

Due to the resiliency of the plastic driver, hammer rebound may occur when the seal is seated. Keep clear of the hammer rebound path!

6. Handle the seal by its outside diameter avoiding any contact with the seal lips. During installation, use the proper driver to make sure that the seal is mounted properly.
7. Use a rubber mallet to drive the seal tool in until the flange bottoms on the housing cover bore face. The flange will locate the seal at the proper depth.



Guidelines for Reusing Yoke

⚠ CAUTION

Do not use the yoke if it has any damage on the seal surface (nicks or scratches).

The surface of the yoke and the lips of the seal form a critical interface which retains the axle's lubricant while sealing the axle from outside contaminants. The condition of the yoke hub's surface is a very important factor in determining seal life.

Carefully inspect the seal surface area of the yoke hub for signs of wear and damage. Do not reuse the yoke if there is noticeable wear, such as heavy grooving, beyond normal polishing from the seal lips.

Note: Do not rework the yoke with abrasives such as emery paper or crocus cloth. Clean the surface of the yoke as necessary using chemical cleaners. Remove all trace of the chemicals from the yoke after cleaning.

⚠ CAUTION

Do not use wear sleeves. Wear sleeves increase the yoke hub surface diameter and cause premature seal wear and repeat seal failure.

New Welded D-Housing Cover

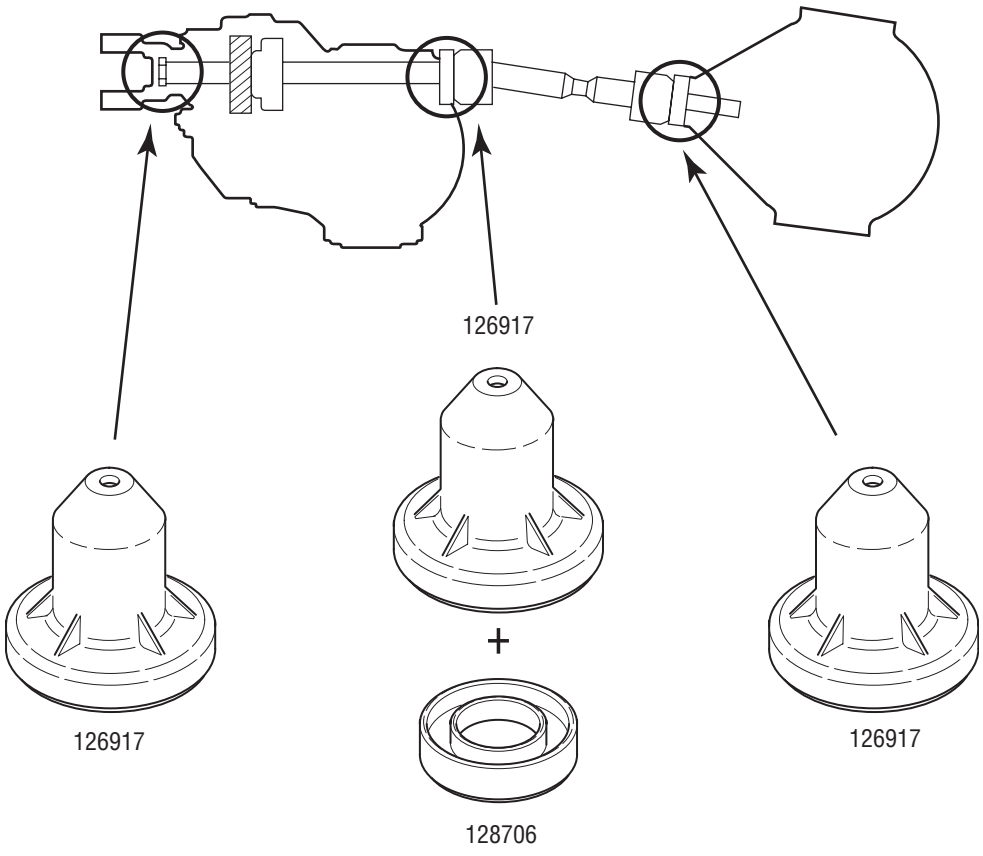
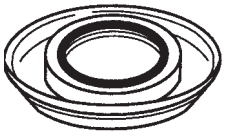
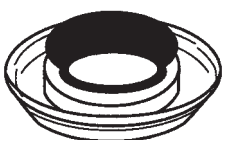
Lube Quantity Difference
0 (zero)

Standout of Output Shaft Yoke
Length increased by 6 mm (.25"), this should not have any significant impact on inter-axle driveline length or drive line angles.

Interchangeability of Parts

A cross reference chart of “OLD” axle housing to “NEW” axle housings with welded on covers will be published in a separate bulletin. The bolt on D-Housing covers will remain available for service.

Service Kit 217414

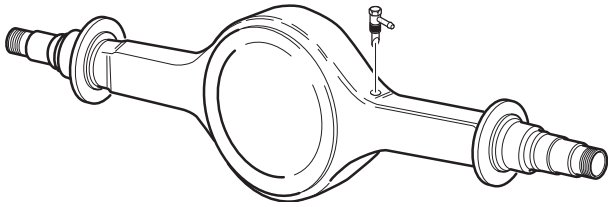
	D - Input	***D - Output***	***R - Pinion***
Location			
Tool			
	D - Input	***D - Output***	***R - Pinion***
Old Seal			
New Seal			

Housing Breather

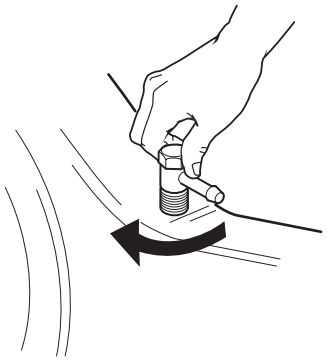
Install New Axle Housing Breather (Metal and Plastic)

Dana uses an axle housing breather that consists of a fitting, hose and clamp assembly. This breather design has improved resistance to water ingestion, clogging caused by dirt, ice or snow buildup around the base of the breather. See installation instructions below (all views from rear).

1. Install fitting in breather hole.

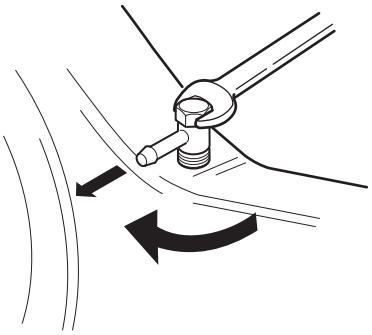


2. Tighten fitting finger tight.

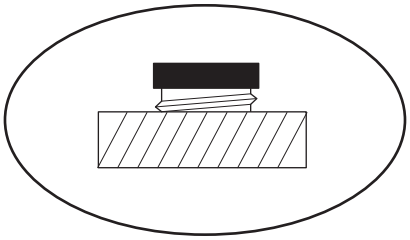


3. Using a 3/4" wrench:

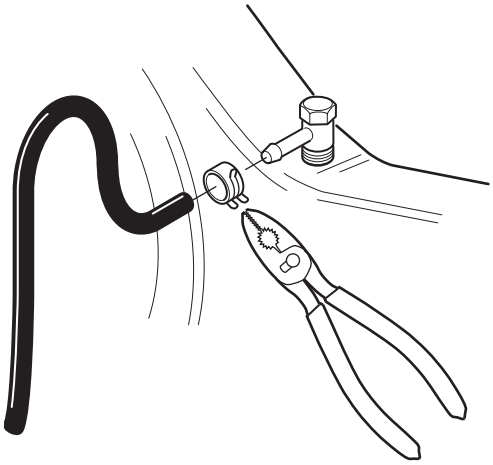
- **Metal only:** rotate the fitting at least 1/2 turn until nipple points to rear. Torque to 5 lbs. ft.



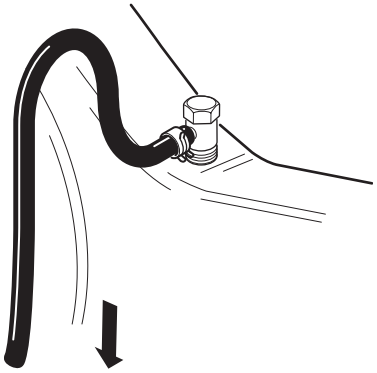
- **Plastic only:** tighten until one thread is showing.



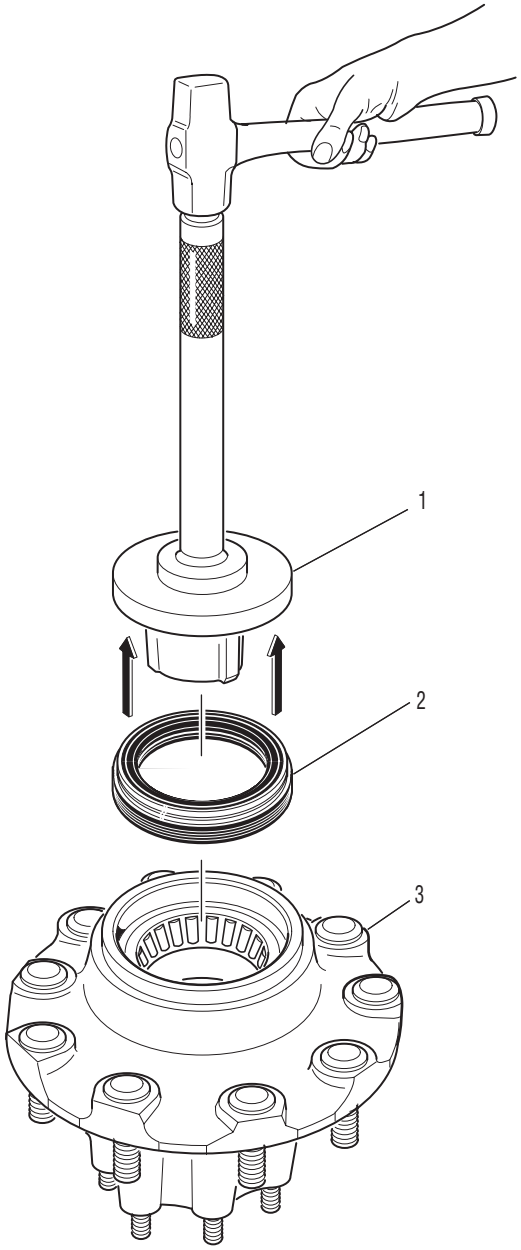
4. Insert hose onto fitting, long end down.



5. Push hose firmly against fitting. Rotate hose to point down.



Wheel End Seal - Parts Exploded View



1 - Installation tool
2 - Seal
3 - Rear hub

Remove and Overhaul Wheel End Seal

⚠ WARNING

Never work under a vehicle supported by only a jack. Always support vehicle with stands. Block the wheels and make sure the vehicle will not roll before releasing the brakes.

⚠ IMPORTANT

Wheel end seals can be easily damaged during handling. Leave the seal in its package until installation to prevent damage or contamination.

1. Remove outer bearing and wheel.
2. Remove oil seal.
3. Remove inner bearing.
4. Remove old wear sleeve (2-piece design only) with a ball peen hammer and discard.

⚠ CAUTION

Do not cut through the old wear sleeve. Damage to the housing may result.

5. Inspect spindle journal and hub bore for scratches or burrs. Recondition with an emery cloth as required.

Note: Deep gouges can be repaired by filling gouge with hardening gasket cement and smoothing with emery cloth.

6. Clean hub cavity and bearing bores before reassembly. Be sure to remove contaminants from all recesses and corners.
7. Clean bearings thoroughly with solvent and examine for damage. Replace damaged or worn bearings.

⚠ CAUTION

Always use the seal installation tool specified by the seal manufacturer. Using an improper tool can distort or damage the seal and cause premature seal failure.

Install Wheel End Seal

1. Before installation, lubricate the following with the same lubricant used in the axle sump.
   - Inner bearing
   - Wheel seal (follow the directions provided by the seal supplier)
2. Place seal on installation tool.
3. Drive seal with installation tool onto hub.

Wheel Adjustment Systems

Adjust Wheel Bearing

⚠ WARNING

Do not mix spindle nuts and lock washers from different systems. Mixing spindle nuts and lock washers can cause wheel separation.

Note: The lock washer for a four-piece tang/dowel-type wheel nut system is thinner than the lock washer for a three-piece tang-type wheel nut system and is not designed to bear against the inner nut.

1. Inspect the spindle and nut threads for corrosion and clean thoroughly or replace as required.

Note: Proper assembly and adjustment is not possible if the spindle or nut threads are corroded.

2. Inspect the tang-type washer (if used). Replace the washer if the tangs are broken, cracked, or damaged.
3. Install the hub and drum on the spindle with care to prevent damage or distortion to the wheel seal.

⚠ CAUTION

A wheel dolly is recommended during installation to make sure that the wheel seal is not damaged by the weight of the hub and drum. Never support the hub on the spindle with just the inner bearing and seal. This can damage the seal and cause premature failure.

4. Completely fill the hub cavity between the inner and outer bearing races with the same lubricant used in the axle sump.
5. Before installation, lubricate the outer bearing with the same lubricant used in the axle sump.

Note: Lubricate only with clean axle lubricant of the same type used in the axle sump. Do not pack the bearings with grease before installation. Grease will prevent the proper circulation of axle lubricant and may cause wheel seal failure.

6. Install the outer bearing on the spindle.
7. Install the inner nut on the spindle. Tighten the inner nut to 200 lbs. ft. (271 N•m) while rotating the wheel hub.

⚠ CAUTION

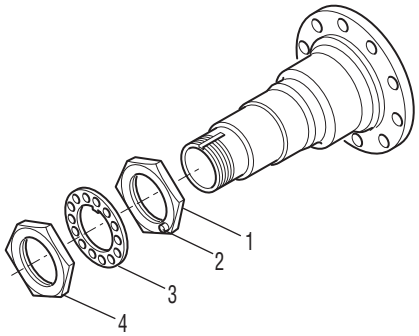
Never use an impact wrench to adjust wheel bearings. A torque wrench is required to assure that the nuts are properly tightened.

8. Back off the inner nut one full turn. Rotate the wheel hub.
9. Retighten the inner nut to 50 lbs. ft. (68 N•m) while rotating the wheel hub.
10. Back off the inner nut exactly 1/4 turn.

Note: This adjustment procedure allows the wheel to rotate freely with 0.001"–0.005" (0.025 mm–0.127 mm) end-play.

11. Install the correct lock washer for the wheel nut system being used.

Three-piece Dowel-type Lock Washer System



1 - Inner nut (P/N 119882)
2 - Dowel pin
3 - Dowel-type lock washer (P/N 119883)
4 - Outer nut (P/N 119881)

a. Install the Dowel-type lock washer on the spindle.

Note: If the dowel pin and washer are not aligned, remove washer, turn it over and reinstall. If required, loosen the inner nut just enough for alignment.

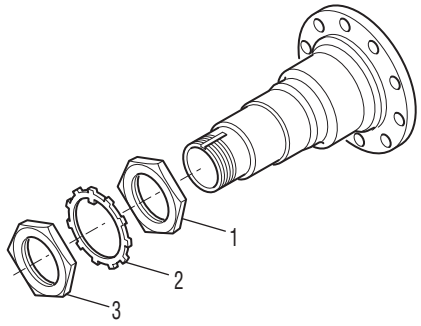
⚠ IMPORTANT

Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

b. Install the outer nut on the spindle and tighten to 350 lbs. ft. (475 N•m).

c. Verify end-play. See Verify Wheel End-play Procedure on page 99.

Three-piece Tang-type Lock Washer System



1 - Inner nut (P/N 11249)
2 - Tang-type lock washer (P/N 11245) .123" thick
3 - Outer nut (P/N 11249)

a. Install the Tang-type lock washer on the spindle.

⚠ IMPORTANT

Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

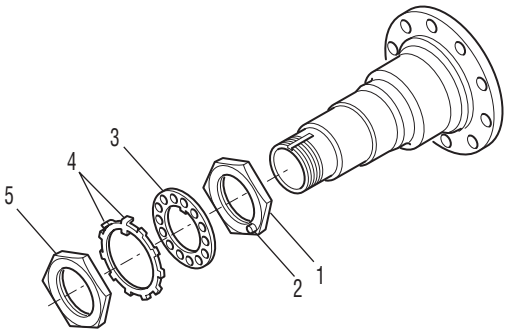
b. Install the outer nut on the spindle and tighten to 250 lbs. ft. (339 N•m)

c. Verify end-play. See Verify Wheel End-play Procedure on page 99.

d. After verifying end-play, secure wheel nuts by bending one of the locking washer tangs over the outer wheel nut and another tang over the inner wheel nut.

e. Go to step 12.

Four-piece Tang/Dowel-type Lock Washer System



1 - Inner nut (P/N 119882)
2- Dowel pin
3 - Dowel-type lock washer (P/N 119883)
4 - Tang-type lock washer (P/N 129132) .0478" thick
5 - Outer nut (P/N 119881)

a. Install the Dowel-type lock washer on the spindle.

Note: If the dowel pin and washer are not aligned, remove washer, turn it over and reinstall. If required, loosen the inner nut just enough for alignment.

⚠ IMPORTANT

Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

b. Install the Tang-type lock washer on the spindle.

c. Install the outer nut on the spindle and tighten to 250 lbs. ft. (339 N•m).

d. Verify end-play. See Verify Wheel End-play Procedure on page 99.

e. After verifying end-play, secure the outer nut by bending (180° apart) two opposing tangs of the locking washer over the outer nut.

12. Install the following:
    - New gasket at axle shaft flange.
    - Axle shaft.
    - Axle flange nuts and tighten to specified torque.
13. Lubricate axle wheel ends.

Verify Wheel End-play Procedure

Verify that end-play meets specification using a dial indicator. An indicator with 0.001" (0.03 mm) resolution is required. Wheel end-play is the free movement of the tire and wheel assembly along the spindle axis.

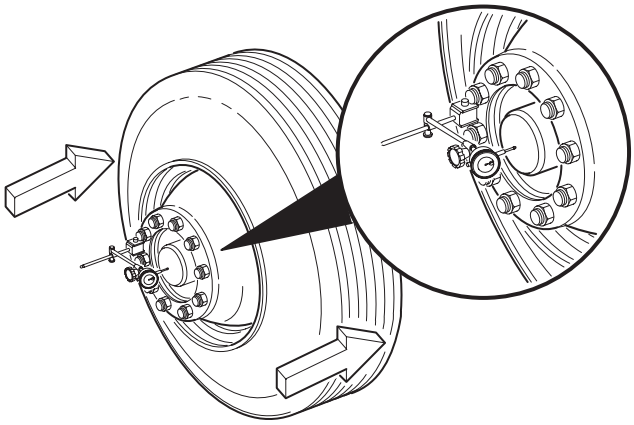
Correct end-play is .001"–.005" (0.025–0.125 mm).

1. Attach a dial indicator with its magnetic base to the hub or brake drum as shown below.
2. Adjust the dial indicator so that its plunger or pointer is against the end of the spindle with its line of action approximately parallel to the axis of the spindle.
3. Grasp the wheel assembly at the 3 o'clock and 9 o'clock positions. Push the wheel assembly in and out while oscillating it to seat the bearings. Read bearing end-play as the total indicator movement.

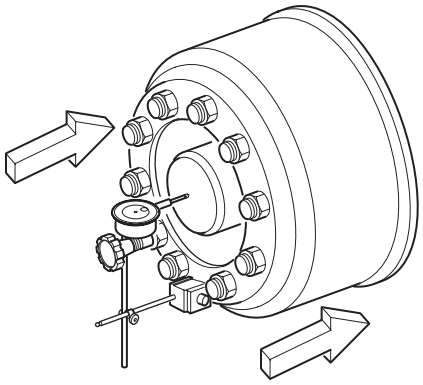
⚠ CAUTION

If end-play is not within specification, readjustment is required.

Adjust End-play with Tire and Wheel Assembly



Adjust End-play with Wheel Hub



Readjust Wheel End-play Procedure

Excessive End-play: If end-play is greater than .005" (.127 mm), remove the outer nut and pull the lock washer away from the inner nut, but not off the spindle. Tighten the inner nut to the next alignment hole of the dowel-type washer (if used). Reassemble the washer and retorque the outer nut. Verify end-play with a dial indicator.

Insufficient End-play: If end-play is not present, remove the outer nut and pull the lockwasher away from the inner nut, but not off the spindle. Loosen the inner nut to the next adjustment hole of the dowel-type washer (if used). Reassemble the washer and retorque the outer nut. Verify end-play with a dial indicator.

Fine Tuning the End-play: If, after performing the readjustment procedures, end-play is still not within the .001"–.005" (.025–.127 mm) range, disassemble and inspect the components. If parts are found to be defective, replace the defective parts, reassemble and repeat wheel bearing adjustment procedure. Verify end-play with a dial indicator.

Lubricate Wheel End

⚠ IMPORTANT

Before operating the axle, the wheel hub cavities and bearings must be lubricated to prevent failure.

When wheel ends are serviced, follow Dana's wheel end lubrication procedure before operating the axle.

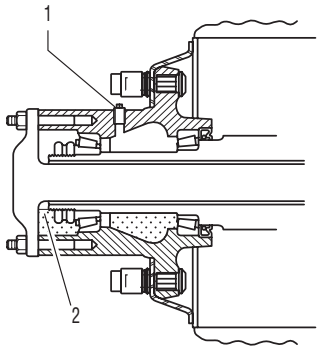
Dana axles may be equipped with either of two wheel end designs:

- Wheel ends **with** an oil fill hole.
- Wheel ends **without** an oil fill hole.

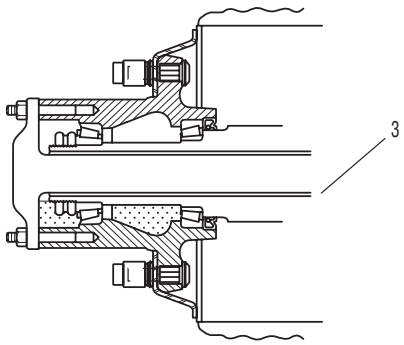
Wheel Ends with an Oil Fill Hole

1. Rotate the wheel end hub until the oil fill hole is up.
2. Remove the oil fill plug.
3. Pour 1/2 pint of axle sump lubricant into each hub through the wheel end fill hole.
4. Install oil fill plug and tighten to specified torque.

Wheel End with Oil Fill Hole



Wheel End without Oil Fill Hole

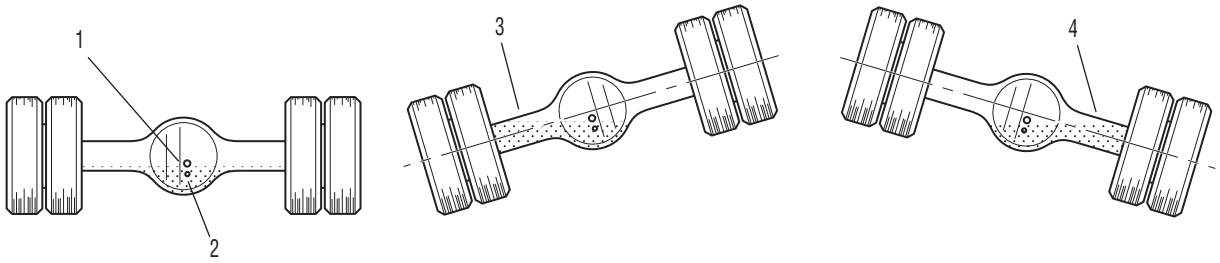


1 - Wheel end oil fill hole
2 - Proper lubricant level
3 - Lubricant flow from sump

Wheel Ends Without Oil Fill Hole

1. With axle level and wheel ends assembled, add lubricant through filler hole in axle housing cover until fluid is level with the bottom of filler hole.
2. Raise the right side of the axle 6 inches or more. Hold axle in this position for one minute.
3. Lower the right side.
4. Raise the left side of the axle 6 inches or more. Hold axle in this position for one minute.
5. Lower the left side.
6. With axle on a level surface, add lubricant through housing cover oil filler hole until fluid is level with the bottom of the hole.

Note: Axles without wheel end fill holes will require approximately 2.5 additional pints of lubricant to bring the lube level even with the bottom of fill hole.



1 - With axle on level surface, fill housing with oil to bottom of plug
2 - Temperature sensor mounting hole
3 - Oil will run into wheel end
4 - Oil will run into wheel end
5 - Tilt housing side to side (1 minute per side)
6 - Recheck oil level in axle

Lubrication

The ability of a drive axle to deliver quiet, trouble-free operation over a period of years is largely dependent upon the use of good quality gear lubrication in the correct quantity. The most satisfactory results can be obtained by following the directions contained in this manual.

The following lubrication instructions represent the most current recommendations from the Axle & Brake Division of Dana Corporation.

Approved Lubricants

General -Gear lubrications acceptable under military specification (MILSPEC) MIL-L-2105D (Lubricating Oils, Gear, Multipurpose) are approved for use in Dana Drive Axles. The MIL-L-2105D specification defines performance and viscosity requirements for multigrade oils. It supersedes both MIL-L-2105B, MIL-L-2105C and cold weather specification MIL-L-10324A. This specification applies to both petroleum-based and synthetic based gear lubricants if they appear on the most current "Qualified Products List" (QPL-2105) for MIL-L-2105D.

Note: The use of separate oil additives and/or friction modifiers are not approved in Dana Drive Axles.

Synthetic based - Synthetic-based gear lubricants exhibit superior thermal and oxidation stability, and generally degrade at a lower rate when compared to petroleum-based lubricants. The performance characteristics of these lubricants include extended change intervals, improved fuel economy, better extreme temperature operation, reduced wear and cleaner component appearance. The family of Dana Spicer[a] gear lubricants represents a premium quality synthetic lube which fully meets or exceeds the requirements of MIL-L-2105D. These products, available in both 75W-90 and 80/W-140, have demonstrated superior performance in comparison to others qualified under the MILSPEC, as demonstrated by extensive laboratory and field testing. For a complete list of Spicer¨ approved synthetic lubricants contact your local Dana representative. See back cover of this manual for appropriate phone number.

Makeup Lube - Maximum amount of non-synthetic makeup lube is 10%.

Recommendations for Viscosity/Ambient Temperature

The following chart lists the various SAE Grades covered by MIL-L-2105D and the associated ambient temperature range from each. Those SAE grades shown with an asterisk (*) are available in the Spicer family of synthetic gear lubricants.

The lowest ambient temperatures covered by this chart are -40°F and -40°C. Lubrication recommendations for those applications which consistently operate below this temperature range, must be obtained through Dana Corporation by contacting your local Dana representative.

Grade	Ambient Temperature Range
75W	40°F to -15°F (-40°C to -26°C)
75W-80	40°F to 80°F (-40°C to 21°C)
75W-90*	40°F to 100°F (-40°C to 38°C)
75W-140	40°F and above (-40°C and above)
80W-90	15°F to 100°F (-26°C to 38°C)
80W-140*	15°F and above (-26°C and above)
85W-140	10°F and above (-12°C and above)

* Available in the Spicer family of synthetic gear lubricants.

Lube Change Intervals

This product combines the latest manufacturing and part washing technology. **When filled with a Dana approved synthetic lubricant at the factory, the initial drain is not required.**

Change the lubricant within the first 5,000 miles of operation when not using a Spicer approved synthetic lubricant in either a new axle or after a carrier head replacement. Base subsequent lubricant changes on a combination of the following chart and user assessment of the application and operating environment.

Severe Service Lubrication Change Intervals - Severe service applications are those where the vehicle consistently operates at or near its maximum GCW or GVW ratings, dusty or wet environments, or consistent operation on grades greater than 8%. For these applications, the ON/OFF HIGHWAY portion of the chart should be used. Typical applications are construction, logging, mining and refuse removal.

Note: Clean metallic particles from the magnetic filler plug and drain plugs. Clean or replace the breather yearly to avoid lube contamination due to water ingestion.

Synthetic or Mineral	Lubricant	SAE	Change Interval for Line Haul	Change Interval for Vocational
Synthetic*	SHAES-256	SAE 75W-90	500,000 miles [800,000 Km] or 5 years	120,000 miles (193,000 Km) or 1year
Synthetic**	SHAES-256	SAE 75W-90, 75W-140	250,000 miles (400,000 Km) or 3 years	60,000 miles [96,500 Km] or 1 year
Mineral Base	MIL-L-2105E/J02360, API GL-5 Gear Oil, MIL-PRF-2105E	75W, 75W-90, 75W-140, 80W-90, 85W-140	120,000 miles [193,000 Km] or 1 year	60,000 miles [96,500 Km] or 1 year

* Axles using LMS wheel end system

** Axles using adjustable wheel bearing system

Change Lube

Drain

Drain when the lube is at normal operating temperature (150°–200°F). It will run freely and minimize the time necessary to fully drain the axle, this insures the axle is flushed.

Unscrew the magnetic drain plug on the underside of the axle housing and allow the lube to drain into a suitable container.

Note: Dispose of all used lubricants properly by following disposal methods approved for mineral or synthetic based oils.

After initial oil change, inspect drain plug for large quantities of metal particles. These are signs of damage or extreme wear in the axle. Clean the drain plug and replace it after the lube has drained completely. Inspect breather for clogging or corrosion. Clean or replace as necessary.

Fill

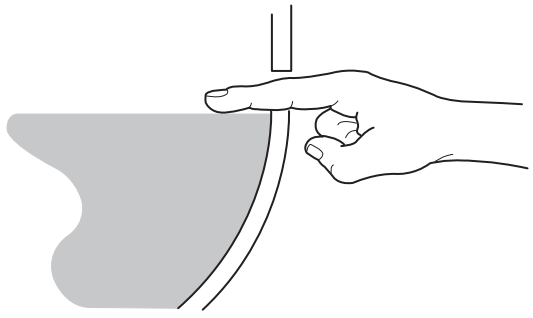
Front Axle

a. With vehicle on level ground, remove the filler hole plug from the axle housing cover and fill the axle with approved lubricant until level with the bottom of the hole.

Rear Axle

a. Remove the filler hole plug from the axle housing cover and fill the axle with the approved lubricant until level with the bottom of the hole.

b. If wheel ends were removed, follow instructions in wheel end servicing page 100.

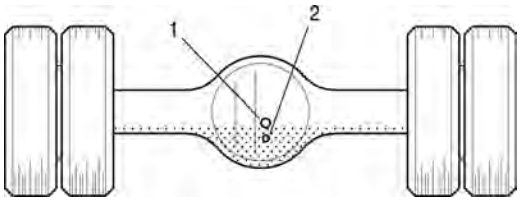


Correct lube level at bottom of filler hole.

Always use the filler hole as the final reference. If lube is level with the bottom of the hole, the axle is properly filled.

Note: Lube fill capacities (see chart) are basic guidelines and will vary based on the angle the axle is installed in a particular chassis. Torque fill plug to 40–60 lbs. ft. (54–82 N•m).

TIP: The axle can be filled through the axle housing breather hole. Fill until lube level is even with the bottom of filler hole in axle housing rear cover.



1 - With axle on level surface, fill housing with oil to bottom of plug.
2 - Temperature sensor mounting hole.

Tandem Axle Model Number	*Pints*	*Liters*
461 DD(P), DS(P)	*43*	*20.3*
461 DP(P), DT(P)	*46*	*21.8*
461 RC, RP, RT	*39*	*18.5*
461 RD, RS	*40*	*18.9*
462 DD(P), DS(P)	*40*	*18.9*
462 RD, RS	*37*	*17.5*
463 DD(P), DP(P), DS(P), DT(P)	*40*	*18.9*
463 RD, RP, RS	*37*	*17.5*
521 DD(P), DP(P), DS(P), DT(P)	*42*	*19.9*
521 RC, RD, RP, RS, RT	*39*	*18.5*
581 DD(P), DP(P), DS(P)	*42*	*19.9*
581 RD, RP, RS	*39*	*18.5*
601 DC(P), DD(P), DP(P)	*42*	*19.9*
601 RP	*39*	*18.5*
651 DP(P)	*41*	*19.4*
651 RP	*37*	*17.5*
652 DP(P)	*41*	*19.4*
652 RP	*37*	*17.5*

Standpipes

Drive axles are lubricated with oil drawn from a large sump integral to the assembly. Most axle designs attempt to position vital components such as pinion bearings in close proximity to this sump, keeping them bathed in a generous supply of oil at all times.

When drive axles are installed at severe angles in vehicle chassis, the position of these components is changed relative to the oil sump. The same effect is present when the vehicle travels up a steep grade. Oil in the sump remains level while the axle itself tilts up or down. This makes it possible for bearings and gears located well forward in the assembly to "starve" for lubrication even though the axle is filled to the base of the fill plug hole as recommended by the manufacturer.

Axles should be modified with standpipes to raise lube levels whenever chassis installation angles exceed 10° and when the vehicle must negotiate continuous or lengthy grades on a routine basis.

The chart gives standpipe recommendations for vehicles operating in consistently mountainous areas.

Axle Installation Angle	Axle Location	Quantity (pints)
12	Rear	19*
10	Rear	21*
8	Rear	22.5*
6	Forward Rear	24.5 25
4	Forward Rear	27 25
2	Forward Rear	29 26
0	Forward Rear	31 28

* Does not allow for standpipes

Capacities do not include wheel equipment requirements. An additional 1–2 pints is required in each wheel hub.

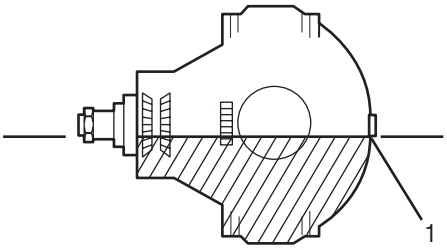
Tandem Forward Axles			
Installation Angle*	5-10% Grade	10-15% Grade	15-20% Grade
0	-	-	-
3	-	-	2.00”
5	-	1.00”	2.25”
7	-	1.25”	2.50”
10	1.50”	1.75”	2.75”
13	1.75”	2.00”	3.00”
15	2.50”	2.50”	3.25”

* Pinion pointing upward

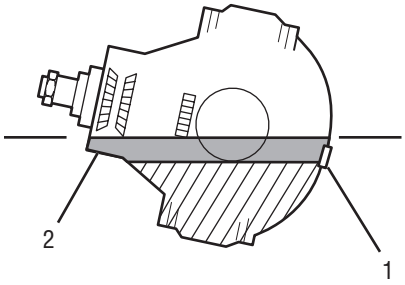
Tandem Rear Axles			
Installation Angle*	5-10% Grade	10-15% Grade	15-20% Grade
0	-	-	-
3	-	-	1.00”
5	-	1.00”	1.75”
7	-	1.75”	2.00”
10	-	2.00”	2.25”
13	1.00”	2.25”	2.75”
15	2.00”	2.50”	3.25”

* Pinion pointing upward

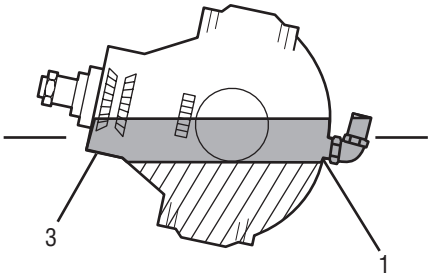
Horizontal Mounting



12° Installation



12° Installation with Standpipe



1 - Oil fillller hole
2 - Lost oil capacity
3 - Additional oil capacity

Note: Grades must be continuous or lengthy in nature. Monitor oil temperatures before installing standpipes. Axles should operate at approximately 100°F (38°C) over ambient temperature and not exceed 240°F (116°C).

Final Check

Prior to putting vehicle back into service, run the vehicle to bring axle lube up to temperature. Check filler and drain plugs and axle joint for leakage. Re-tighten to specifications as necessary.

Torque Chart

Fastener	Axle Model	Class	Size	Tool Size	Lbs.-ft.	N-m
Carrier & Cap-Misc. Parts	Bearing Cap Capscrew-All Models	8	13/16 - 10	1-1/8	370-430	501-583
	Bearing Adjuster Lock Capscrew	5	5/8 - 11	1-1/8	160-176	217-239
	Pinion Bearing Sleeve Capscrew	5	5/16 - 18	---	16-20	21-27
	Thrust Screw Jam Nut	4	M24	36mm	150-190	203-258
	Shift Fork Cover Capscrew	5	7/16 - 14	---	35-45	47-61
Ring Gear Nut/Bolt	Forward & Rear Single Speed	8	5/8 - 18	15/16	180-220	242-298
	Forward & Rear Two Speed	8	9/16 - 18	---	110-130	149-176
Pinion Bearing Cage Capscrew	All Forward Models	8	9/16 - 12	---	155-175	210-237
	All Rear Models	5	5/8 - 11	---	160-176	217-239
Differential Case Capscrew	440/460/461/521	8	9/16 - 12	---	116-130	157-176
	480/581 Models	8	5/8 - 11	---	165-195	224-264
Input Shaft Nut	All Forward Models	---	1 7/8 - 12	---	840-1020	1139-1383
		---	M48 X 1.5	70mm	840-1020	1139-1383
Input Shaft Brg. Cover Capscrew	All Forward Models	5	1/2 - 13	---	75-85	101-115
Axle Housing Misc. Related Parts	Carrier to Hsg-Capscrew All Models	8	5/8 - 18	---	220-240	271-312
	Carrier to Hsg-Stud Nut at Dowels	8	5/8 - 18	---	150-170	203-230
	Carrier to Hsg Capscrew-Forward Axles	8	5/8 - 11	---	220-240	271-312
	Axle Hsg Cover-Capscrew	5	7/16 - 14	---	65-78	88-106
	Axle Hsg Cover-Stud Nut at Dowels	---	7/16 - 20	---	65-78	88-106
	Oil Drain Plug	---	---	1/2 drive	40-60	54-81
	Magnetic Fill Plug	---	13/16	7/8 wrench	40-60	54-81
Output Shaft (Thru Shaft) Nut	D440/460/480	---	1 3/4 - 12	---	840-1020	1139-1383
	D461/521/581	---	M42 X 1.5	55mm	789-996	1070-1310
Pinion Nut	D440/460/480	---	1 3/4 - 12	---	980*	1329*
- Slotted nut torque to 980 lbs. ft.	D461/521/581	---	M42 X 1.5	65mm	840-1020	1139-1383
- Continue tightening nut to	R440/460/480	---	1 3/4 - 12	---	840-1020	1139- 1383
align slot with the nearest hole in pinion shank	R461/521/581	---	M42 X 1.5	55mm	789-966	1070-1310
Power Divider Misc. Parts	Inter-Axle Differential-Nuts/Bolts	8	5/16 - 24	---	17-23	23-31
	PDU Cover Capscrew-Standard	6	9/16 - 13	---	110-126	149-170
	PDU Cover Capscrew-Socket Head	8	9/16 - 12	---	115-125	155-169
Lube Pump Misc. Parts	Cover Capscrew	5	1/4 - 20	7/16	85-105 lbs. in.	10-12
	Drive Gear Locknut	---	7/16 - 20	5/8	35-45	47-61
	Filter Screen/Pipe Plug	---	3/4 - 14	1 1/16	40-60	54-81
Misc. IAD Lockout Parts	Body Capscrew	5	7/16 - 14	5/8	48-56	65-76
Original Style	Body Cover Capscrew	5	1/4 - 20	7/16	96-108 lbs.in.	10-12
	Push Rod Nut	---	3/8 - 24	---	20-26	27-35
Aluminum Canister Style	Hsg Bracket Capscrew	5	7/16 - 14	---	48-56	65-76
	Push Rod Nut	---	3/8 - 24	5/8	13-17	18-23

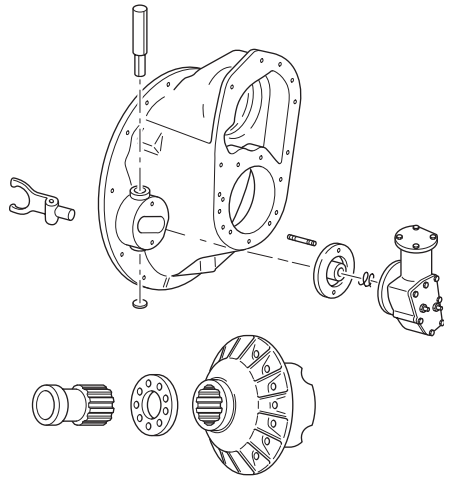
Fastener	Axle Model	Class	Size	Tool Size	Lbs.-ft.	N-m
Cast Iron Cover Style	Cover Capscrew	5	7/16 - 14	5/8	48-56	65-76
	Push Rod Nut	---	3/8 - 24	5/8	13-17	18-23
Wheel End-Misc. Parts	Axle Shaft to Wheel Hub Nuts	---	1/2 - 20	1 1/16	55-71	75-96
		---	5/8 - 18	1 5/16	170-190	230-258
		---	3/4 - 16	1 1/8	285-345	386-468
Diff. Lock-Misc. Parts	Shift Cylinder Cover Capscrew	8.8	M10 X 1.4	12mm	28-34	38-46
	Shift Fork Capscrew	12.9	M8 X 1.25	6mm Allen	12-15	16-20
	Selector Switch	---	M14 X 1.5	24mm	10-12	14-16
	Diff. Lock Cylinder Shipping Screw	---	1/4 - 18	Snug to Engage Clutch Teeth		
	Bearing Adjuster Lock	5	5/8-11	---	160-176	216-238
* Slotted nut - Torque to 980 lbs. ft. then continue tightening nut to align slot with the nearest hole in pinion shank.						

Wheel Differential Lock

Comparison Information on Dana Wheel Differential Locking Axles

This section covers Dana wheel differential locking axles. The basic concept of Dana Wheel Differential Locking axles are the same, but the designs vary model to model. When servicing your differential lock axle, pay close attention to all NOTES, TIPS and WARNING signs that will assist you while you work on your axle. The differential lock axles listed below are grouped together by design type.

Note: Information for Type 1 and 2 differential lock axles are not covered in this manual, refer to AXSM-0048 and AXSM-0046 for information pertaining to those axles.



Parts unique to type 3 differential lock axles.

Type 1*		Type 2*	Type 3
19055D	21080D	19060D	DD/RD461
21065D	23080D	21060D	DD/RD521
22065D	26080D	22060D	DD/RD581
23070D	23105D	DD/RD404	
23085D	26105D	DD/RD454	
26085D	30105D		
* See AXSM-0048 and AXSM-0046 Service Manual for technical information			

Type 1 Style Differential Lock Axles Feature:

- A sliding curvic clutch
- A fixed curvic clutch
- The flange half differential case is externally splined
- Uses double spline or extended spline axle shaft (11" spline length) on flange half side of axle
- Uses standard spline axle shaft (4" spline length) on plain half side of axle
- The differential lock selector switch is located on the carrier/cap assembly

Type 2 Style Differential Lock Axles Feature:

- A sliding curvic clutch
- A fixed curvic clutch
- The plain half differential case is externally splined
- Uses extended spline axle shaft (11" spline length) on plain half side of axle
- Uses extended spline axle shaft (11" spline length) on plain half side of axle
- Uses standard spline axle shaft (4" spline length) on flange half side of axle
- The differential lock selector switch is located on the differential lock shift cylinder

Type 3 Style Differential Lock Axles Feature:

- A two-speed carrier/cap assembly
- A splined clutch splined internally
- The differential lock is shifted by air shift units
- The differential lock selector switch is located on the air shift unit
- The flange half of the case is splined internally
- Uses extended spline axle shaft (11" spline length) on flange half side of axle
- Uses standard spline axle shaft (4" spline length) on plain half side of axle

Differential Lock Theory of Operation

The Dana Wheel Differential Lock is an optional feature for Dana axles. In operation, it positively locks the wheel differential, power flows to the tires without any differential action, providing improved traction under adverse road conditions.

The differential lock is driver-controlled through a cab-mounted valve. The locking mechanism is air-operated to engage a sliding clutch and lock the wheel differential. It is spring-operated to disengage the lock and permit the wheel differential to function normally, dividing torque equally between the tires and compensating normally for cornering or tire size variations.

The differential lock also includes a selector switch (electric) which senses clutch engagement and sends an electrical signal to the cab mounted indicator light (or an audible signal device).

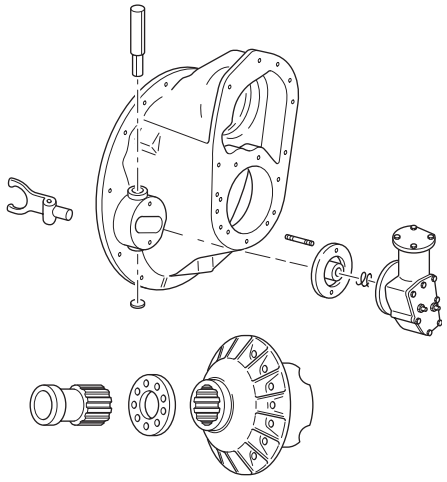
⚠ WARNING

Do not use your wheel differential lock when traveling downhill. Do not use your wheel differential lock at speeds over 25 MPH.

The wheel differential lock consists of three major assemblies (see illustrations).

- An air shift unit assembly, which operates a shift fork and push rod assembly.
- A shift fork and push rod assembly which engages and disengages the differential sliding clutch.
- A sliding clutch is splined to the flange half differential case which is internally splined.

The differential lock also includes a selector switch (electric), located on the air shift unit, which senses clutch engagement and sends an electrical signal to a cab-mounted indicator light (and/or audible signal device).



Parts unique to type 3 differential lock axles.

Control Systems

Two types of systems may be used to control the Differential Lock operation:

- Transmission low-range interlock control system
- Direct driver-controlled system

Note: The interlock system is preferred for vehicles equipped with an air-shifted, low-range transmission. It is designed to insure the differential lock is not left engaged (and to prevent accidental engagement) when transmission is in high range.

Transmission Low Range Interlock Control System (preferred system)
The wheel differential is locked manually with the transmission in low range. It is unlocked by the driver or unlocked when the transmission is shifted out of low range.

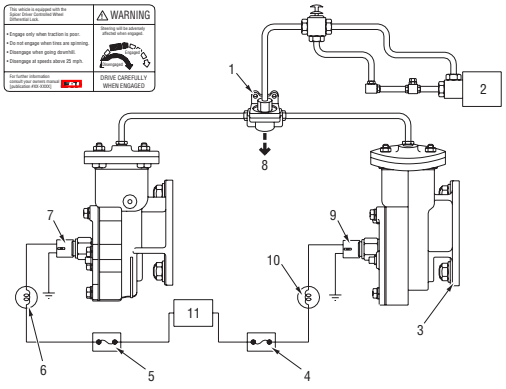
With this system, the wheel differential lock can only be engaged when the transmission is in low range. Operation is as follows:

1. When the transmission is in a range above low speed, the transmission low range control valve is closed shutting off air supply to the cab-mounted control valve and differential lock shift units. The differential lock is disengaged and the wheel differential functions normally.
2. With the transmission in low-range, the transmission control valve opens and supplies pressure to the cab mounted control valve.
3. When the driver places the cab-mounted control valve in the lock position and with the assist pressure from the transmission control circuit, tank air pressure is supplied to the differential lock shift units through the cab-mounted control valve. The shift fork is moved to engage the sliding curvic clutch with the flanged half differential case.
4. When the control switch is placed in the unlock position, air pressure supply to the shift unit is shut off and air pressure is released from the shift unit. A compression spring moves the shift fork to disengage the sliding clutch from the flanged case half unlocking the wheel differential.

Note: If the transmission is shifted out of low-range (with cab mounted control valve in the lock position), the air pressure to the differential shift units is shut off automatically. The transmission low range valve closes, shuts off air assist supply to the cab mounted control valve which, in turn, releases the tank air pressure from the air shift units.

If the driver subsequently shifts back into low range, the differential lock will not re-engage automatically.

Note: With either control system, torque on the wheel differential must be relieved to allow the differential to fully lock or unlock. Press clutch.

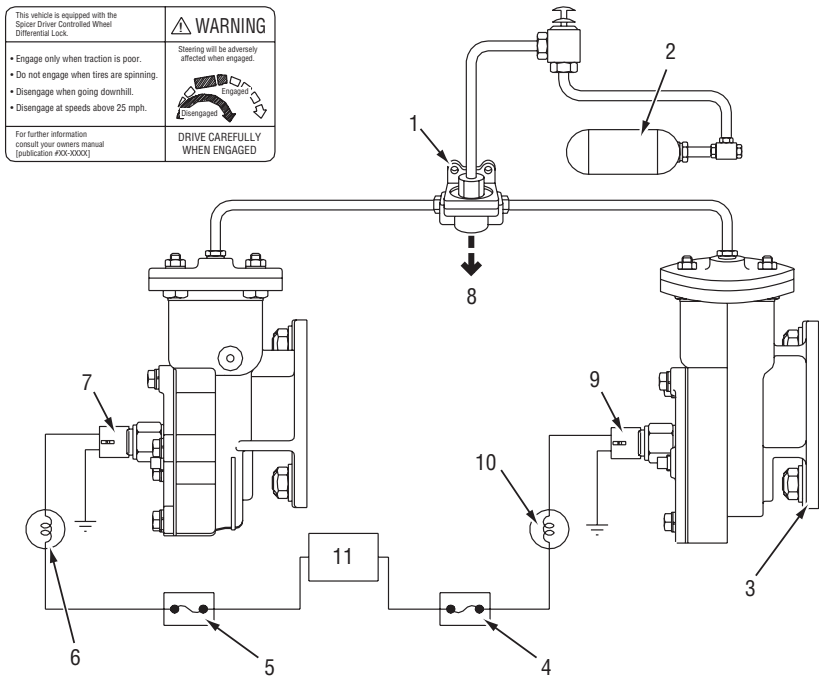


1 - Quick release valve
2 - Transmission
3 - Rear axle wheel differential lock air shift unit
4 - Fuse or circuit breaker
5 - Fuse or circuit breaker
6 - Indicator light or audible signal
7 - Wheel differential lock selector switch
8 - Exhaust
9 - Wheel differential lock selector switch
10 - Indicator light or audible signal
11 - Power supply

Direct Driver-Controlled System

The driver manually locks and unlocks the wheel differential, using a cab-mounted air valve. The following description assumes the system includes a cab-mounted air valve and a solenoid valve as shown in the illustration. Operation is as follows:

1. With control switch in the unlock position, the wheel differential functions normally.
2. When the control valve is placed in the lock position, the air supply solenoid valve opens and air pressure activates the shift unit.The shift fork is moved to engage the sliding clutch which, in turn, locks the wheel differential.
3. When the control switch is placed in the unlock position, air pressure supply to the shift unit is shut off and air pressure is released from the shift unit. A compression spring moves the shift fork to disengage the sliding clutch from the flanged case half unlocking the wheel differential.



1 - Quick release valve
2 - Dry air supply tank 80 - 120 PSI
3 - Rear axle wheel differential lock air shift unit
4 - Fuse or circuit breaker
5 - Fuse or circuit breaker
6 - Indicator light or audible signal
7 - Wheel differential lock selector switch
8 - Exhaust
9 - Wheel differential lock selector switch
10 - Indicator light or audible signal
11 - Power supply

Dual Range Axle Shift Systems

There are two shift system designs predominantly used to select range of an Dana dual range tandem axle.

1. Standard System. For range selection, a cab-mounted air shifter valve operates two air shift units mounted on the axles.

   The inter-axle differential lockout is of the straight-air type and air-operated to engage lockout and spring-released to disengage lockout

2. Axle Range Interlock System. This system has an added feature to prevent axle shifting when the inter-axle differential is locked out. The axle range air shifter valve for this system includes an Interlock Pin Assembly to provide the interlock feature.

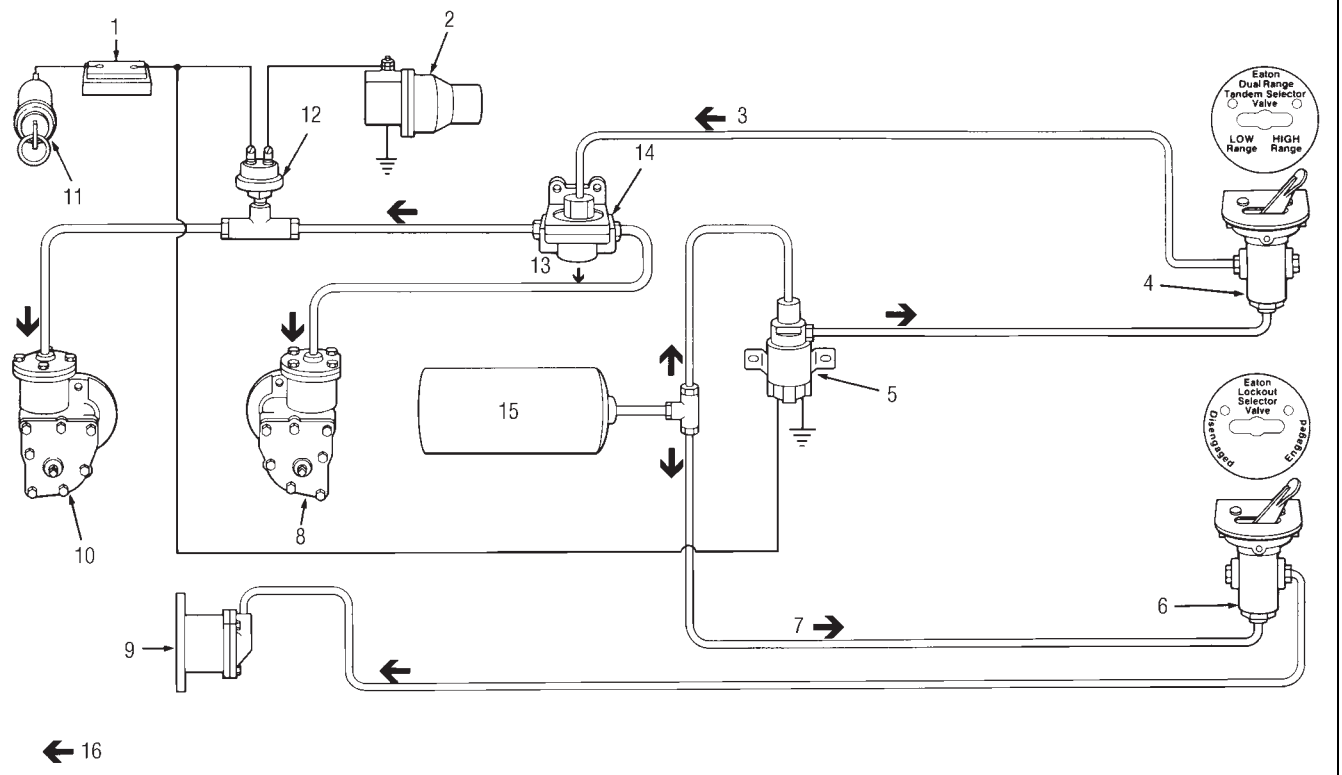
   The inter-axle differential lockout is of the straight-air type. It is equipped with an Interlock Control Valve which controls air pressure delivery to the shifter valve Interlock Pin.

   Detailed information on these systems is included in this manual.

"Reverse-Air" Type Inter-axle Differential Lockout.
Some shift systems may include this lockout design. It is spring-operated to engage or "Lock" the differential and air-operated to disengage or "Unlock" the differential.

For information on this type lockout, or other system design variations, contact your local Dana representative.

Standard System for Axle Range Selection and Inter-Axle Differential Lockout (straight air type)



1 - Circuit breaker †‡ 2 - Speedometer adapter† 3 - Air pressure 4 - Axle range shifter valve (open in high range) 5 - Solenoid valve‡ (exhaust system when de-energized) 6 - Inter-axle differential lockout shifter 7 - Air pressure	8 - Forward axle shift unit 9 - Inter-axle differential lockout cylinder 10 - Rear axle shift unit 11 - Ignition switch†‡ 12 - Pressure switch† (normally closed) 13 - Exhaust 14 - Quick release valve 15 - Dry air tank 16 - Air pressure with axle in high range, inter-axle differential engaged	† Pressure switch and speedometer adapter required for vehicles with transmission drive speedometers. ‡ Solenoid valve required for vehicles not equipped with automatic safety brakes.

Description

The standard dual range shift system consists of:

1. A manually-operated, air shifter valve to change axle range.
2. A quick release valve which provides for fast release of air pressure from the axle shift units.
3. Two air shift units mounted on the axles. These shift units are mechanically connected to the axle shift forks and sliding clutches which, in turn, shift axles into Low or High Range.

For vehicles not equipped with automatic safety brakes, an ignition-controlled solenoid valve exhausts the system and downshifts the axles when the ignition switch is turned off. The electrical circuit is protected by a circuit breaker.

For vehicles equipped with transmission-drive speedometers, the system includes a speedometer adapter which compensates speedometer readings when axle is in Low Range. The adapter is operated by an electrical switch mounted on or near the quick-release valve. The switch is normally-closed and is opened by air pressure.

With axles in Low Range, the switch is closed and the adapter is energized. The adapter operates with a ratio compatible with the axle Low Range for proper speed readings. With axle in High Range, the airlines are pressurized and the pressure switch is open. The adapter now operates with 1:1 ratio for proper speed readings in High Range.

Axle Shift System Operation High Range
When shifter valve is moved to the High position, the valve is opened and air pressure is supplied through the quick release valve to both axle shift units. When driveline torque is interrupted, the shift units will shift both axles to High Range.

Low Range
When shifter valve is moved to the Low position, the valve is closed. Air pressure in the shift units is exhausted through the quick release valve. When driveline torque is interrupted, both axles are shifted to Low Range and held in this position by shift unit return springs.

Inter-Axle Differential Lockout System

The lockout air shift system consists of:

1. A manually-operated air shifter valve which controls engagement or disengagement of the inter-axle differential.
2. A lockout cylinder which operates under air pressure. This cylinder is mechanically-connected to a shift-fork and sliding clutch. The clutch engages or disengages a differential helical-side gear to “Lock” or “Unlock” the differential.

Lockout System Operation
For operation description, refer to the following page.

“Standard” Lockout (straight-air type)

Description: The “standard” lockout unit is of the straight-air type and is air-operated to engage lockout and spring-released to disengage lockout. The piston is mechanically connected to the shift fork and sliding clutch. The clutch engages or disengages the helical-side gear to lock or unlock the inter-axle differential.

Disengage Lockout
(Unlock differential)

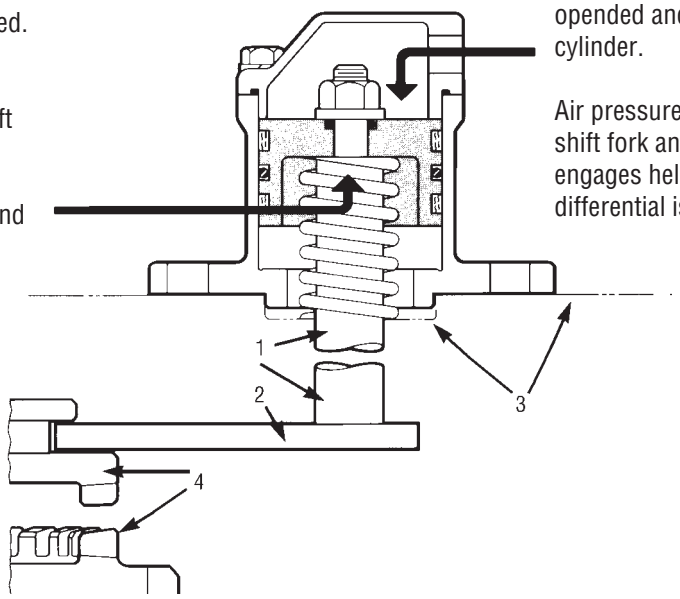
When the air shifter valve lever is moved to the disengaged or "Unlock" position, the valve is closed and air pressure in the cylinder is exhausted.

Air pressure at piston is released. Spring pressure moves piston, shift fork and sliding clutch. Clutch is disengaged from helical-side gear. Inter-axle differential is unlocked and functions normally.

Engage Lockout
(Lock Differential)

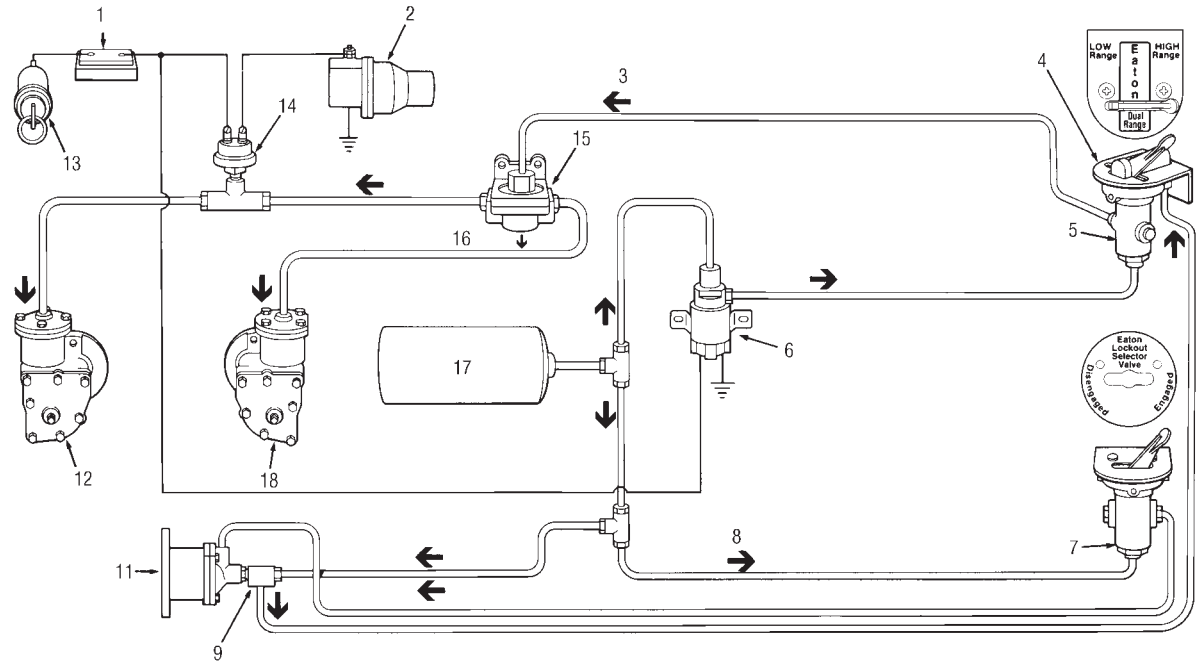
When the air shifter valve lever is mov
the engaged or "lock" position, the valv
opended and supplies air to the lockou
cylinder.

Air pressure enters cover - moves pist
shift fork and sliding clutch. Clutch
engages helical-side gear. Inter-axle
differential is locked out (or not opera



1 - Push rod
2 - Shift Fork
3 - Power divider cover
4 - Sliding clutch engages or disengages helical - side gear

Axle Range Selection and Inter-Axle Differential Lockout System



1 - Circuit breaker †‡ 2 - Speedometer adapter † 3 - Air pressure 4 - Interlock pin assembly (mounted in cover) (blocks lever with lockout engaged) 5 - Axle range shifter valve (open in high range) 6 - Solenoid valve ‡ (exhaust system when de-energized) 7 - Inter-axle differential lockout shifter valve (open in “lock” position) 8- Air pressure	9 - Interlock control valve (open when lockout is engaged) 10 - Air pressure with axle in high range, inter-axle differential engaged, and axle shifter valve lever blocked. 11 - Inter-axle differential lockout cylinder 12 - Rear axle shift unit 13 - Ignition switch †‡ 14 - Pressure switch † (normally closed) 15 - Quick release valve 16 - Exhaust 17 - Dry air tank 18 - Forward axle shift unit	† Pressure switch and speedometer adapter required for vehicles with transmission drive speedometers. ‡ Solenoid valve required for vehicles not equipped with automatic safety brakes.

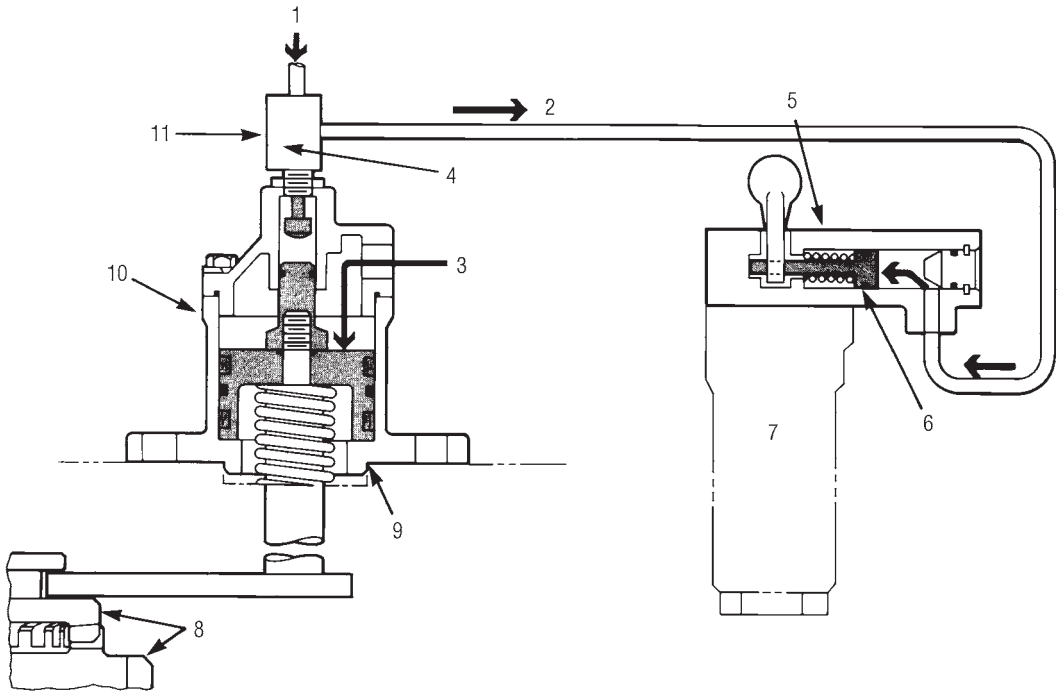
Description and Operation

The Axle Range Interlock feature in this system is designed to prevent axle shifting when the inter-axle differential is locked out (or when lockout is engaged).

The basic shift system operates the same as the standard shift system to shift axle and engage or disengage lockout. However, it varies by adding an Interlock Pin Assembly to the axle range shifter valve and an Interlock Control Valve to the lockout cylinder. These two components are interconnected with airlines (see illustration above). In operation, the Interlock Pin Assembly blocks movement of the axle range shifter valve lever when air pressure is present. Refer to the following page for operation description.

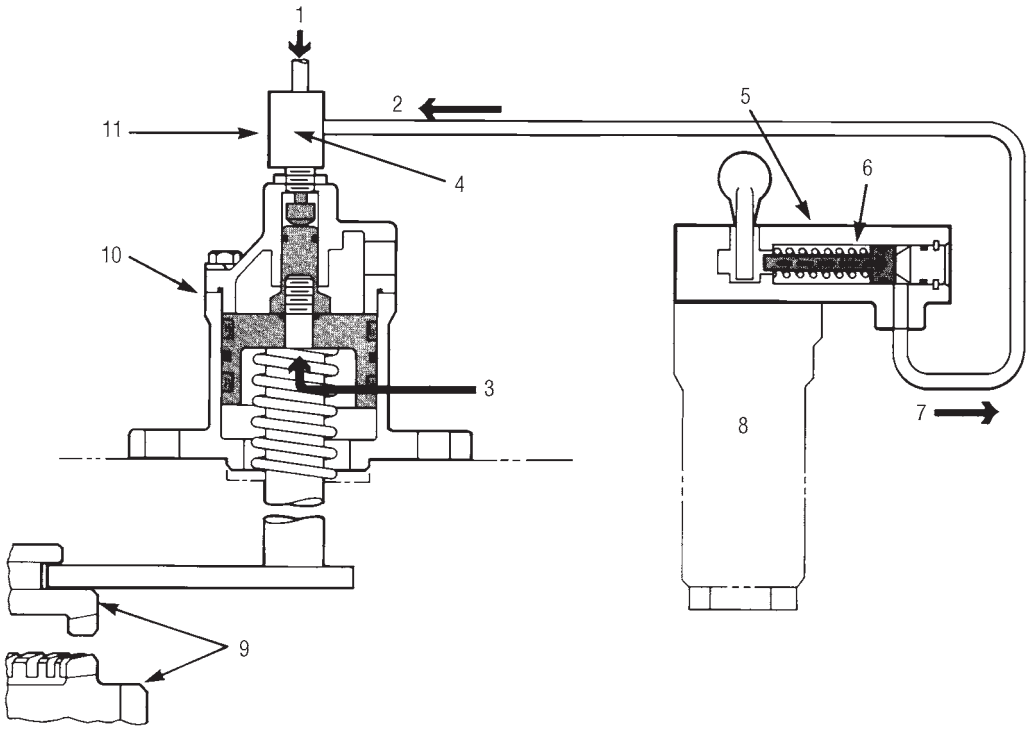
Axle Range Interlock Operation

Engage Lockout (Lock Differential) (Axle in High or Low Range)



1 - Reservoir air pressure 2 - Air pressure 3 -Air pressure (from lockout shifter valve) moves piston to engaged lockout 4- Lockkout cylinder piston movement allows interlock control valve to open	5 - Air pressure is applied to the interlock pin. Pin moves to block shifter valve lever. Axle range cannot be changed. 6 - Interlock pin assembly 7 - Axle range shifter valve 8 - sliding clutch engages helical - side gear 9 - Lockout cylinder	10 - Lockout cylinder 11 - Interlock control valve

Disengage Lockout (Unlock Differential) (Axle in High or Low Range)



1 - Reservoir air pressure 2 - Air exhaust 3 - Air pressure at piston is released. Return spring moves piston to disengage lockout. 4 - Lockout cylinder piston movement closes interlock control valve	5 - Air pressure to interlock pin is exhausted through control valve port. Return spring moves piston and pin to release shifter valve lever 6 - Interlock pin assembly 7 - Air exhaust 8 - Axle range shifter valve	9 - Sliding clutch disengages helical - side gear 10 - Lockout cylinder 11 - Interlock control valve

Troubleshooting

Check for Air Pressure and Air Leaks
A simple method for quickly locating troubles in a shift system can be accomplished by listening for possible air leaks and for sound which would indicate mechanical shifting.

Axle Shift System

1. When system includes a solenoid valve, turn ignition "ON" to energize and open the solenoid valve. If electrical system is functioning, air pressure should be present at valve outlet connection.
2. Move axle shifter valve lever to High Range. In this position, air pressure should be present in the entire system. Check for air leaks.
3. Move axle shifter valve lever to Low Range. In this position, air pressure should be present only up to axle shifter valve.
4. To check axle for shifting, operate shifter lever back and forth from "LO" to "HI". If the shift unit is operating, a definite reaction will be evident by sound of parts movement.
5. If air pressure is satisfactory and shift unit does not operate, disassemble and inspect shift unit.

Check Pressure Switch
In Low Range, the pressure switch is closed and electrical circuit is complete to the speedometer adapter. In High Range, air pressure opens the pressure switch, breaks the electric circuit to the speedometer adapter.

To check pressure switch operation, shift to High Range and probe switch terminals. No voltage should be present. Replace a faulty pressure switch as an assembly.

Check Quick Release Valve
The quick release valve provides a means of quickly exhausting air from system when axle is shifted from High to Low Range.

To check valve operation, listen for audible air exhaust from valve when shifting axle from High to Low Range. Replace a faulty quick release valve as an assembly.

Check Lockout (standard)
With shifter valve in the "Lock" position, air pressure is present in the entire lockout system. Check for air leaks with lockout engaged. Repair leaks.

Note: If lockout will not engage with air pressure present at cover connection, remove and check lockout cylinder.

Check Lockout (with axle range interlock)
With shifter valve in "Lock" position, lockout is engaged and air pressure is present in all lines and components of the lockout and interlock system. Check for air leaks with lockout engaged. Repair leaks.

Note: If lockout will not engage with air pressure present at cylinder cover side connection, remove and check cylinder.

Check Interlock Control Valve
Air pressure is present at the inlet connection at all times. With lockout engaged, the valve should open and air pressure should be present at the valve side connection.

With lockout disengaged, valve should be closed, blocking air at the side connection. Check valve operation in both lockout positions. If valve operation is faulty, replace the assembly.

Check Interlock Pin Assembly
Air pressure is present at the axle range shifter valve cover connection when lockout is engaged. Air pressure should operate locking pin to block movement of the axle shifter valve lever.

To check operation, move the lockout shifter lever to the "Lock" position. If lever operation is not blocked, check for air pressure at the Interlock Pin connection. If air pressure is present, repair Interlock Pin Assembly.

Check Electrical System

Check Solenoid Valve

1. When ignition switch is “ON,” solenoid valve is energized and air pressure is available to operate the system. When ignition switch is “OFF,” solenoid valve is de-energized and exhausts the system which downshifts axle to low range. Check wiring and circuit breaker for defects that would cause shorts or open circuits.
2. Make sure valve has a good ground connection to the frame. With power at valve, check operation as follows:
    - Disconnect lead wire and airline outlet at valve and install air pressure gauge.
    - Apply power to valve and observe air gauge reading. Operating pressure should be approximate reservoir pressure.
    - If gauge indicates approximate pressure, valve is okay.
    - If gauge indicates low or no pressure, valve is faulty. Replace valve assembly.

Check Speedometer Adapter

1. Make sure adapter is grounded to vehicle chassis.
2. Check wiring for shorts or grounds and trace electrical circuit from ignition switch through circuit breaker, pressure switch to adapter.
3. Check for power supply at adapter terminal. With axle shifter valve in High Range, pressure switch is open and power is not delivered to adapter. With shifter valve in Low Range, the pressure switch is closed and power is delivered to operate the speedometer adapter. If power supply is okay, adapter is faulty. Replace adapter assembly.

Proper Vehicle Towing

Without Wheel Differential Lock

Lift the drive wheels completely off of the ground or damage will occur.

⚠ WARNING

Do not lift the front wheels (non-drive wheels). This alters the oil's position in the drive axle, draining it away from the drive pinion and its bearings. If the pinion is rotated under these conditions for any period of time, bearings will overheat resulting in axle damage or failure.

If this is impossible to lift the drive wheels, remove all axle shafts to prevent gear rotation and cap the wheel hubs to prevent loss of lubricant and a possible road hazard. See the following section Proper Vehicle Towing with Wheel Differential Lock for removal procedure.

With Wheel Differential Lock

Follow this procedure to remove all axle shafts preventing gear rotation with the drive wheels and possible lubrication damage.

1. Engage the wheel differential lock, indicator light is on (move vehicle to verify engagement).
2. Shift transmission into neutral.
3. With vehicle stationary, release the air pressure on the wheel differential lock shift system and apply the parking brake.
4. Disconnect the air supply and fitting at the shift cylinder.
5. Install the shipping capscrew 128642 (.250 X 18 X 1.5") NPSM screw. GM models require part number 128274 (M12 X 1.5 X 38mm) screw. Tighten capscrew to manually engage the wheel differential lock until the indicator light is on and the differential lock is completely engaged.
6. Remove the axle shafts.
7. Install temporary cover on hub to prevent contamination entering and also to prevent the loss of lubricant.

With Wheel Differential Lock (Type 3 Only)

Follow these listed procedures for vehicle towing when the drive axles are equipped with Type 3 wheel differential lock.

Note: To eliminate the need for disconnecting drivelines and axle shafts, trucks/tractors should be towed from the REAR whenever possible.

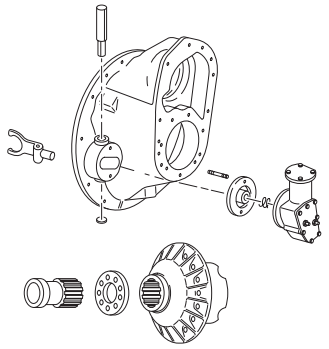
The following procedure should be followed for vehicle towing when the drive axle wheel ends are running on pavement (vehicle being towed from the front). Removing the axle shafts prevents gear rotation with the drive wheels and possibly lubrication damage.

Towing Vehicles from the Front

1. For Type 3 differential lock axles. As a common practice put the axles in the unlocked position.
2. Shift transmission into neutral.
3. Block wheels.
4. Connect air lines from the tow truck's air reservoir system to charge the primary air system of the disabled truck/tractor–preferably to the inlet fitting of the unit's air dryer.
5. Release the emergency/spring brakes of the disabled truck/tractor. Then, manually cage the spring brakes. Do not back off the slack adjusters.
6. Remove the axle shafts, note the specific location of the axle shafts.

Note: Spicer Type 3 (461/521/581) differential lock axle shafts are location specific. The axle shaft with the 11" spline length belongs on the flange half side of axle (same side as the shift unit). Failure to put the correct axle shaft in its intended location will lead to an inoperable differential locking axle.

7. Install temporary cover on hub to prevent contamination from entering and also to prevent the loss of lubricant.

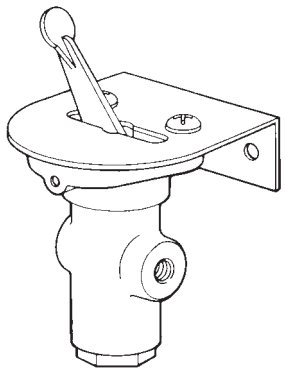


Parts unique to type 3 differential lock axles.

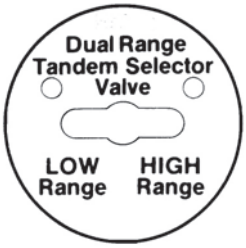
Axle Shift System Components

Air Shifter Valves (Standard System)

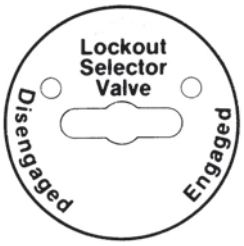
Note: For air shifter valve repair instruction, refer to pertinent manufacturer's literature. See instructions below for Interlock Pin Assembly repair.



Typical Air Shifter Valve for Standard Systems, Axle Range Selection and Inter-axle Differential Lockout.

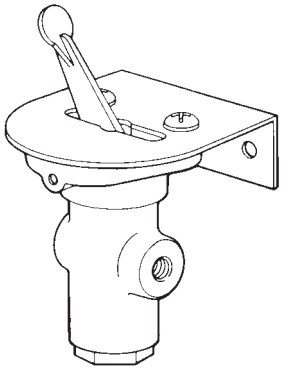


Axle Range Selector Name Plate (Standard System)

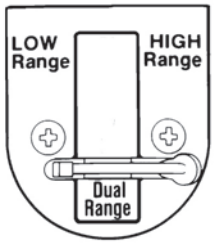


Inter-Axle Differential Lockout Name Plate

Air Shifter Valve (Axle Range Interlock System)

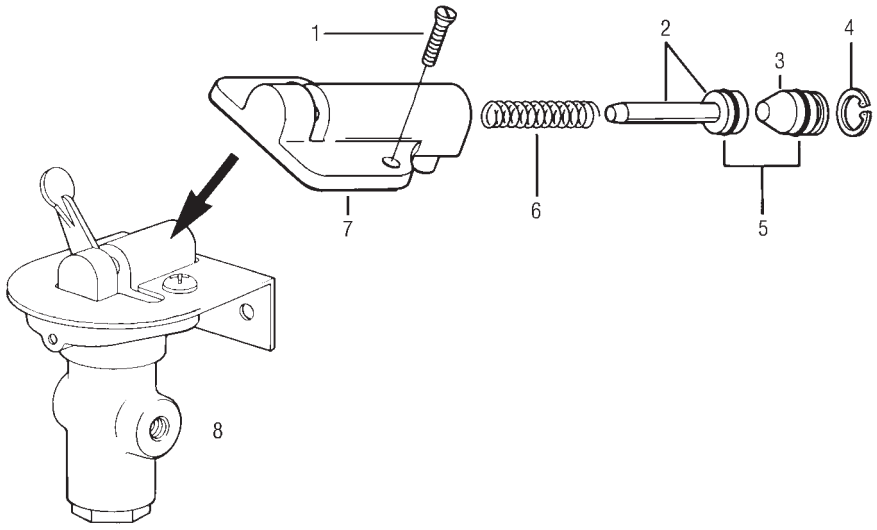


Axle Range Interlock Air Shifter Valve. The Valve for the Inter-axle Differential Lockout is the same as the Standard System.



Axle Range Selector Name Plate (System with Axle Range Interlock)

Axle Range Shifter Valve Interlock Pin Assembly



1 - Mounting screw 2 - Interlock pin and piston 3 - Piston stop 4 - Snap ring 5 - O-rings	6 - Compression spring 7 - Piston housing 8 - Air shifter valve assembly

Note: Before reassembly, lubricate o-rings with a high-viscosity silicone oil or barium grease o-ring lubricant.

Assembly Pin. Install o-rings on piston and piston stop. Insert spring, piston and piston stop in housing and secure with snap ring.

Note: Interlock pin and piston must reciprocate freely in the piston housing when compressed against the compression return spring.

Note: For ease of assembly, insert a pin or drill bit (5/64" max. diameter) into the piston stop to guide the piston stop as it is installed into the piston housing.

Note: The interlock pin assembly may be disassembled for cleaning and inspection. However, parts are only available as a complete assembly (shifter valve and interlock assembly).

Disassemble Pin. Remove snap ring, then remove piston stop, piston and spring from piston housing.

Inter-Axle Differential Lockout
With Interlock Control Valve (straight-air type)

Lockout Cylinder

Disassemble cylinder by performing the following steps:

1. Remove capscrews, lock washers, cover assembly and o-ring.
2. Remove hex-nut piston and o-rings.
3. Remove body capscrews and lock washers, then remove body and piston as an assembly.

Assemble cylinder by performing the following steps:

1. Apply gasket compound to mounting surface on power divider cover.
2. Install lockout body. Secure with capscrews and lock washers. Torque capscrews to 48-56 lbs. ft. (65-76 N•m).

Note: Before installation, soak piston felt oilers in SAE 30 engine oil and lubricate o-rings with a high-viscosity silicone oil or barium grease o-ring lubricant.

3. Install felt oilers and o-ring on piston.
4. Install compression spring over shift fork push rod. Install piston in body. Install o-ring over push rod and in piston. Install hex-nut piston and tighten to 20-26 lbs. ft. (27-35 N•m). Install o-ring on piston.
5. Install o-ring in lockout body cover. Install cover assembly and secure with capscrews and lock washers. Torque capscrews to 6-108 lbs. in. (10-12 N•m).
6. Adjust interlock control valve.

Interlock Control Valve

Repair and Replacement
Replace faulty valve as an assembly.

Remove Valve

1. Loosen lock nut and unscrew valve body from cylinder cover.

Install and Adjust Valve

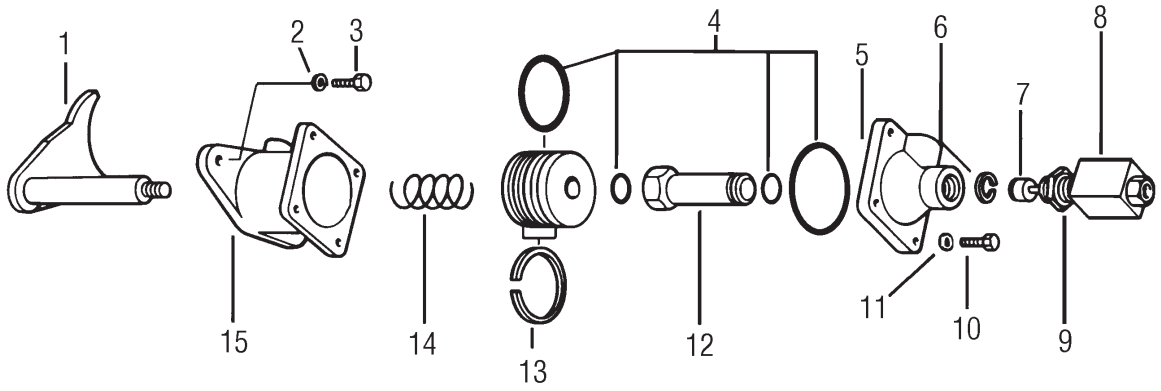
Note: If button is not assembled to valve stem, install as follows:

- Insert valve stem to full depth of the button. Lock in place with set screw. Torque set screw to 6. lbs. in. (0.7 N•m).

1. With button assembled to valve, install lock nut and lock washer on valve body. With lockout cylinder exhausted, screw the valve assembly into the lockout cylinder cover until the valve is seated on hex-nut piston.
2. To adjust, unscrew control valve until the valve air-delivery port is aligned with the lockout cylinder air-inlet port.

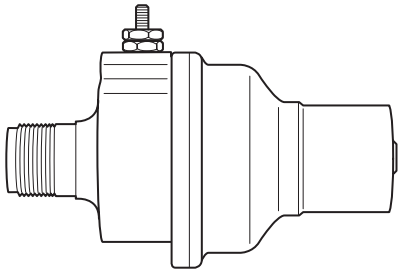
Note: Do not unscrew valve more than 360°.

Lock the valve in place with lock nut. (3.9 N•m)



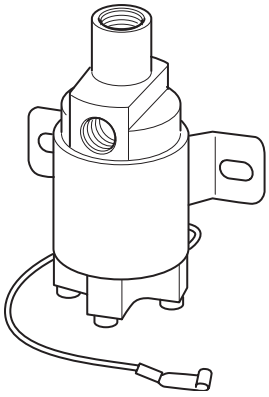
1 - Shift fork and push rod
2 - Lock washer
3 - Capscrew
4 - O-ring
5 - Cover
6 - Lock washer
7 - Control valve button
8 - Interlock control valve
9 - Lock nut
10 - Capscrew
11 - Lock washer
12 - Hex-nut piston
13 - Felt oilers
14 - Compression spring
15 - Lockout body

Speedometer Adapter



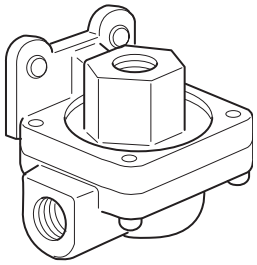
The speedometer adapters are lubricated and sealed for life of the unit. No maintenance is required. Replace a faulty unit.

Solenoid Valve



Replace solenoid valve as an assembly. The valve should not be serviced.

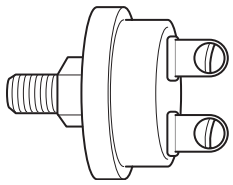
Quick Release Valve



If quick release valve fails to operate properly, it may be repaired as follows:

1. Disassemble valve.
2. Inspect valve body, valve seat and spring (if used) for evidence of faulty operation.
3. Replace faulty parts, then reassemble valve.

Pressure Switch



Replace pressure switch as an assembly.

Theory of Operation

Spicer tandem drive axles described in this publication are single reduction units designed primarily for heavy-duty hauling on and on/off highway.

This type axle assembly provides a vehicle with superior load carrying and roadability characteristics by dividing its work between two axles. The complete tandem assembly consists of two axle units coupled by a power divider.

Power Divider

In operation, the power divider accepts torque from the vehicle driveline and distributes it equally to the two axles.

This assembly is of the two-gear design consisting of an input shaft, inter-axle differential, output shaft and two constant-mesh helical gears.

The inter-axle differential compensates for minor variations in speed between the two axles the same way a wheel differential works between the two wheels of a single drive axle. This unit also acts as a central point in distribution of torque to the two axles.

The power divider also includes a driver-controlled, air-operated lockout. When lockout is engaged, it mechanically prevents inter-axle differentiation for better performance under poor traction conditions.

Gearing

The gearing for each axle is of the spiral bevel design with drive pinion positioned at centerline of the ring gear. The differential and drive pinion are mounted on tapered roller bearings. The wheel differential is a four-pinion, two side gear design.

Lube Pump

These tandem axles are equipped with a lube pump to provide a positive lubrication to the inter-axle differential and other power divider parts. This pump is operated by a drive gear engaged with the input shaft splines. When vehicle is moving in a forward direction, pressurized lube is delivered to the vital power divider parts.

The pump lube system incorporates a magnetic strainer screen. To keep the system clean, the magnet traps minute particles and the screen blocks out large particles of foreign material.

Reference Spicer Lubrication Brochure TCMT-0019 for more information on lube.

Differential Lock-up Assembly

The Spicer wheel differential lock is driver controlled and operated by a carrier-mounted, air-actuated shift unit. In operation it positively locks the wheel differential to provide improved traction under adverse road conditions.

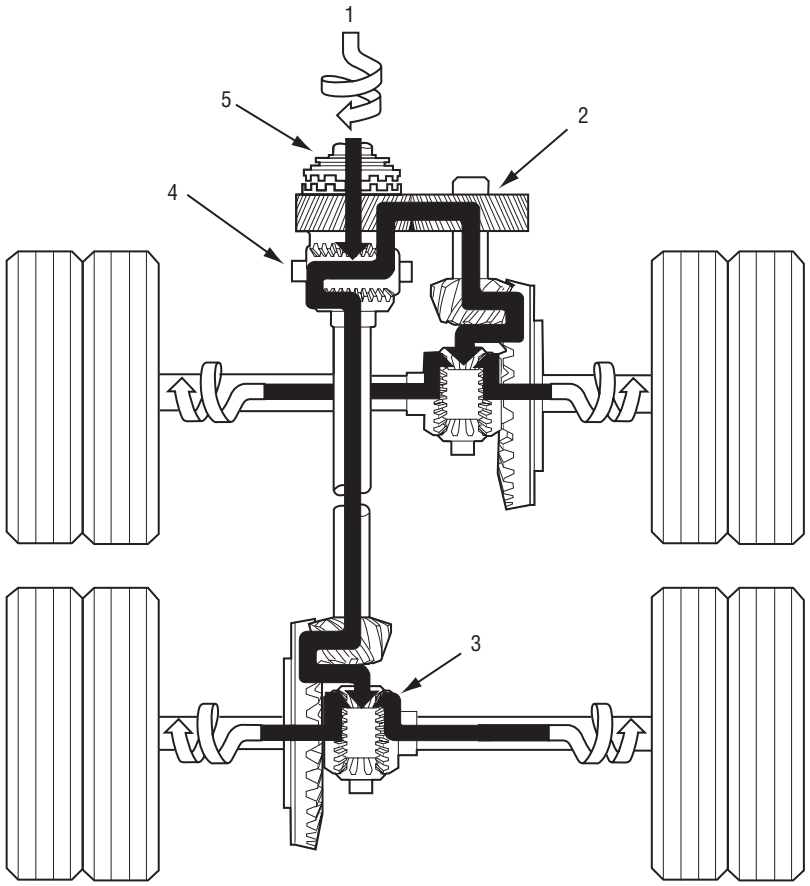
Power Flow and Torque Distribution

Torque Distribution with Lockout Disengaged (Inter-axle Differential is Operating)

Torque (power flow) from the vehicle driveline is transmitted to the input shaft and the inter-axle differential spider. At this point, the differential distributes torque equally to both axles.

For the forward axle, torque is transmitted from the helical-side gear to the pinion helical gear, drive pinion, ring gear, wheel differential and axle shafts.

For the rear axle, torque is transmitted from the output shaft side gear, through the output shaft to the inter-axle driveline, to the drive pinion, ring gear, wheel differential and axle shafts.



Torque is transmitted to both axles without inter-axle differential action

1 - Input torque
2 - Drive is from differential through helical gears to forward gearing
3 - Drive is from differential through output shaft to rear gearing
4 - Inter-axle differential operating
5 - Lockout disengaged

Torque Distribution with Lockout Engaged (Inter-axle Differential is Not Operating)

A lockout mechanism is incorporated in the power divider to enable the vehicle driver to lock out the inter-axle differential and provide maximum traction under adverse road conditions.

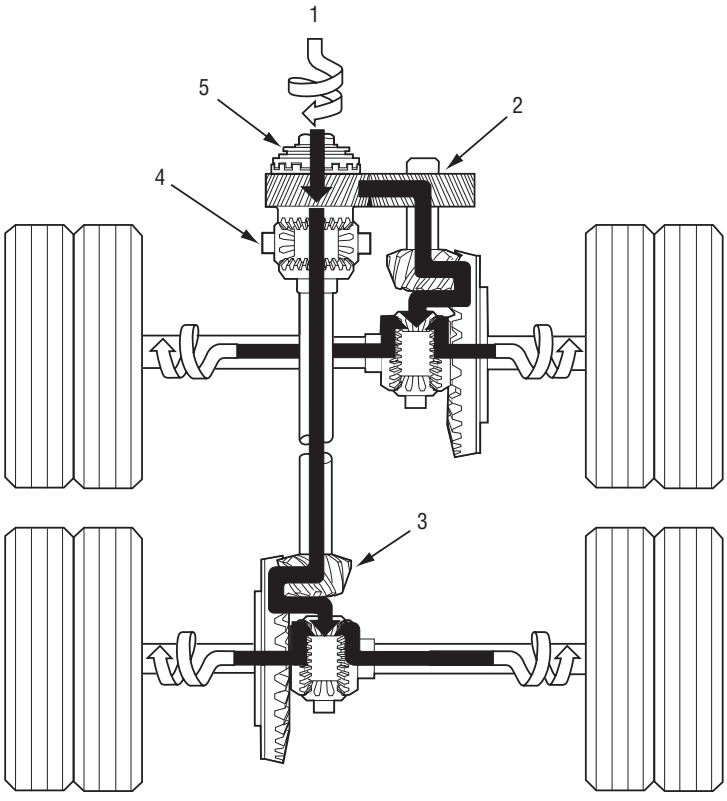
In operation, an air cylinder (controlled by a cab-mounted valve) shifts a sliding clutch on the input shaft. To lock out inter-axle differential action, the clutch engages the helical-side gear and causes this gear, the input shaft and differential to rotate as one assembly. This action provides a positive drive to both axles. The clutch should only be engaged when both axles are rotating at the same speed. Operation should be limited to low traction situations and should be disengaged when normal traction returns. Failure to do so will result in poor handling and damage to the axle components.

With the lockout engaged, torque is distributed to both axles without differential action. The forward axle pinion and ring gear are driven by the helical side gear. The rear axle gearing is driven from the output shaft side gear and inter-axle driveline.

Note: Varied road surface conditions can result in unequal torque distribution between the two axle assemblies.

⚠ CAUTION

Prolonged operation with the lockout engaged can damage axle and driveline components.



Torque is transmitted to both axles without inter-axle differential action

1 - Input torque
2 - Drive is from input shaft through helical gears to forward gearing
3 - Drive is from output shaft side gear to rear gearing
4 - Inter-axle differential not operating
5 - Lockout engaged

Lubrication

The ability of a drive axle to deliver quiet, trouble-free operation over a period of years is largely dependent upon the use of good quality gear lubrication in the correct quantity. The most satisfactory results can be obtained by following the directions contained in this manual.

The following lubrication instructions represent the most current recommendations from the Axle & Brake Division of Dana Corporation.

Approved Lubricants

General: Gear lubrications acceptable under military specification (MILSPEC) MIL-L-2105D (Lubricating Oils, Gear, Multipurpose) are approved for use in Spicer Drive Axles. The MIL-L-2105D specification defines performance and viscosity requirements for multigrade oils. It supersedes both MIL-L-2105B, MIL-L-2105C and cold weather specification MIL-L-10324A. This specification applies to both petroleum-based and synthetic-based gear lubricants if they appear on the most current "Qualified Products List" (QPL-2105) for MIL-L-2105D.

Note: The use of separate oil additives and/or friction modifiers are not approved in Spicer Drive Axles.

Synthetic based: Synthetic-based gear lubricants exhibit superior thermal and oxidation stability and generally degrade at a lower rate when compared to petroleum-based lubricants. The performance characteristics of these lubricants include extended change intervals, improved fuel economy, better extreme temperature operation, reduced wear and cleaner component appearance. The family of Spicer™ gear lubricants represents a premium quality synthetic lube which fully meets or exceeds the requirements of MIL-L-2105D. These products, available in both 75W-90 and 80/W-140, have demonstrated superior performance in comparison to others qualified under the MILSPEC, as demonstrated by extensive laboratory and field testing. For a complete list of Spicer® approved synthetic lubricants contact your local Spicer representative. See back cover of this manual for appropriate phone number.

Makeup Lube: Maximum amount of non-synthetic makeup lube is 10%.

Viscosity/Ambient Temperature Recommendations

The following chart lists the various SAE Grades covered by MIL-L-2105D and the associated ambient temperature range from each. Those SAE grades shown with an asterisk (*) are available in the Spicer family of synthetic gear lubricants.

The lowest ambient temperatures covered by this chart are –40°F and –40°C. Lubrication recommendations for those applications which consistently operate below this temperature range, must be obtained through Dana Corporation by contacting your local Spicer representative.

SAE Grade	***Ambient Temperature Range***
75W	*–41°F to –15°F (–40°C to –26°C)*
75W-80	*–40°F to 80°F (–40°C to 21°C)*
*75W-90**	*–40°F to 100°F (–40°C to 38°C)*
75W-140	*–40°F and above (–40°C and above)*
80W-90	*–15°F to 100°F (–26°C to 38°C)*
*80W=140**	*–15°F and above (–26°C and above)*
85W-140	*10°F and above (–12° and above)*

*Available in the Spicer family of synthetic gear lubricants.

Refer to Spicer Lubrication Brochure TCMT-0021.

Lube Change Intervals

This product combines the latest manufacturing and part washing technology.

Note: When filled with an Spicer approved synthetic lubricant at the factory, the initial drain is not required.

Note: Change the lubricant within the first 5,000 miles of operation when not using a Spicer approved synthetic lubricant in either a new axle or after a carrier head replacement.

Base subsequent lubricant changes on a combination of the following chart and user assessment of the application and operating environment.

Severe Service Lubrication Change Intervals: Severe service applications are those where the vehicle consistently operates at or near its maximum GCW or GVW ratings, dusty or wet environments, or consistent operation on grades greater than 8%. For these applications, the On/Off Highway portion of the chart should be used. Typical applications are construction, logging, mining and refuse removal.

Note: Clean metallic particles from the magnetic filler plug and drain plugs at each maintenance interval. Clean or replace the breather yearly to avoid lube contamination due to water ingestion.

Guidelines - Lube Change Intervals for Drive Axles				
Lubricant Type	On-Highway Miles	Maximum Change Interval	On/Off Highway Severe Service Miles	Maximum Change Interval
Mineral Based	100,000	Yearly	40,000	Yearly
Spicer Approved Synthetic	250,000	3 Years	100,000	Yearly

Refer to Spicer Lubrication Brochure TCMT-0021.

Changing Lube

Draining

Drain when the lube is at normal operating temperature (150°-200°F). It will run freely and minimize the time necessary to fully drain the axle, insuring the axle is flushed.

Unscrew the magnetic drain plug on the underside of the axle housing and allow the lube to drain into a suitable container.

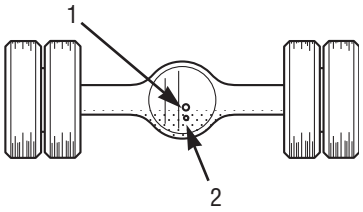
Note: Dispose of all used lubricants properly by following disposal methods approved for mineral or synthetic based oils.

After initial oil change, inspect drain plug for large quantities of metal particles. These are signs of damage or extreme wear in the axle. Clean the drain plug and replace it after the lube has drained completely. Inspect breather for clogging or corrosion. Clean or replace as necessary.

Filling

Front Axle

- With vehicle on level ground, remove the filler hole plug from the center of the axle housing cover and fill the axle with approved lubricant until level with the bottom of the hole.

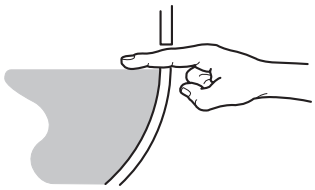


1 - With axle on level surface, fill housing with oil to bottom of plug

Rear Axle

- Remove the filler hole plug from the center of the axle housing cover and fill the axle with the approved lubricant until level with the bottom of the hole.
- If wheel ends were removed.

Always use the filler hole as the final reference. If lube is level with the bottom of the hole, the axle is properly filled.



Note: Lube fill capacities are basic guidelines and will vary based on the angle the axle is installed in a particular chassis. Torque fill plug to 40-60 lbs. ft. (54–81 N•m).

Single Reduction Tandem Drive Axles	Pints	Liters
RS/RD/RA461	42	20
RS/RD/RA521	41	19.5
DS/DD/DA461-P	49	23
DS/DD/DA521-P	48	22.5
DS/DD/DA581-P	48	22.5
RS/RD/RA581	41	19.5

Lube Fill Capacities

TIP: The axle can be filled through the axle housing breather hole. Fill until lube level is even with the bottom of filler hole in axle housing rear cover.

Standpipes

Drive axles are lubricated with oil drawn from a large sump integral to the assembly. Most axle designs attempt to position vital components such as pinion bearings in close proximity to this sump, keeping them bathed in a generous supply of oil at all times.

When drive axles are installed at severe angles in vehicle chassis, the position of these components is changed relative to the oil sump. The same effect is present when the vehicle travels up a steep grade. Oil in the sump remains level while the axle itself tilts up or down. This makes it possible for bearings and gears located well forward in the assembly to "starve" for lubrication even though the axle is filled to the base of the fill plug hole as recommended by the manufacturer.

Axles should be modified with standpipes to raise lube levels whenever chassis installation angles exceed 10° and when the vehicle must negotiate continuous or lengthy grades on a routine basis.

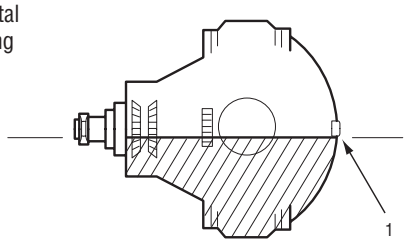
The chart below gives standpipe recommendations for vehicles operating in consistently mountainous areas.

Tandem Forward Axles			
Installation Angle*	**5-10% Grade**	**10-15% Grade**	**15-20% Grade**
0°	-	-	-
3°	-	-	2.00”
5°	-	1.00”	2.25”
7°	-	1.25”	2.50”
10°	1.50”	1.75”	2.75”
13°	1.75”	2.00”	3.00”
15°	2.50”	2.50”	3.25”

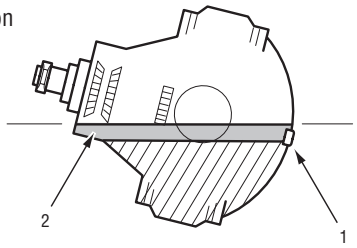
Tandem Rear Axles			
Installation Angle*	**5-10% Grade**	**10-15% Grade**	**15-20% Grade**
0°	-	-	-
3°	-	-	1.00”
5°	-	1.00”	1.75”
7°	-	1.75”	2.00”
10°	-	2.00”	2.25”
13°	1.00”	2.25”	2.75”
15°	2.00”	2.50”	3.25”

***Pinion Pointing Upward**

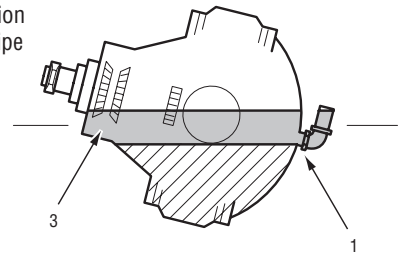
Horizontal mounting



12° Installation



12° Installation with standpipe



1 - Oil filler hole
2 - Lost oil capacity
3 - Additional oil capacity

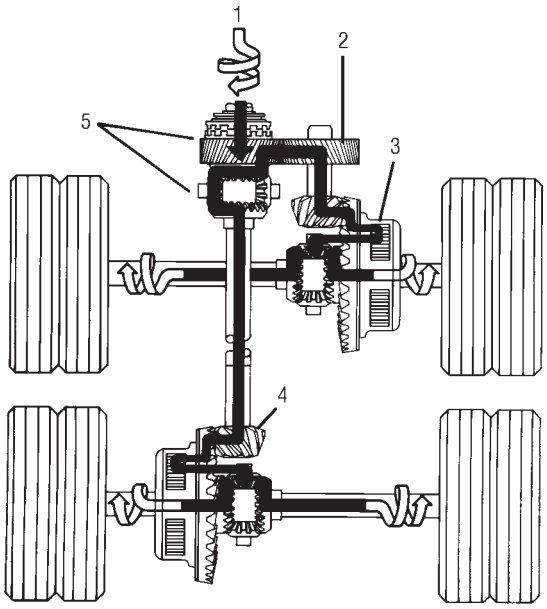
Note: Grades must be continuous or lengthy in nature. Monitor oil temperatures before installing standpipes. Axles should operate at approximately 100°F (38°C) over ambient temperature and not exceed 240°F (116°C).

Final Check

Prior to putting vehicle back into service, run the vehicle to bring axle lube up to temperature.

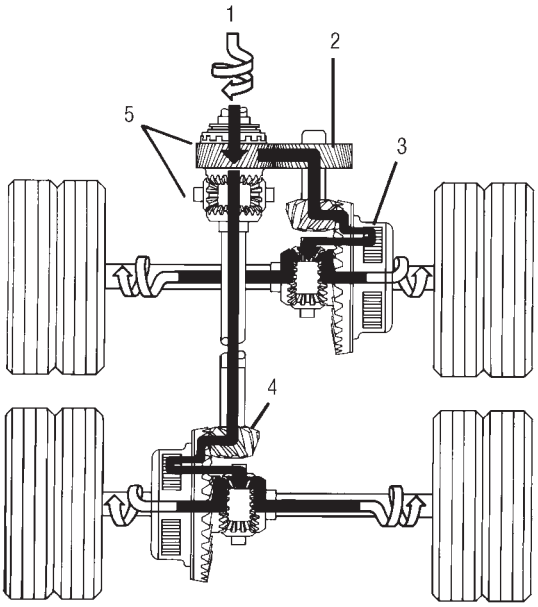
Check filler and drain plugs and axle joints for leakage. Retighten to specifications as necessary.

Torque Distribution in Low Range



Torque is transmitted to both axles through inter-axle differential action.

1 - Input torque
2 - Drive is from differential through helical gears to forward axle gearing.
3 - In low range, the planetary gearing is introduced in the drive system, between the ring gear and wheel differential (both axles).
4 - Drive is from differential through output shaft to rear axle gearing.
5 - Inter-axle differential operating.



Torque is transmitted to both axles through inter-axle differential action.

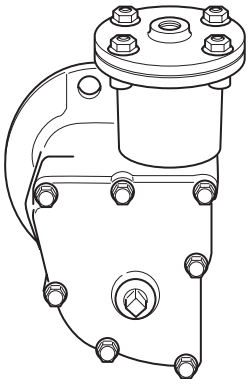
1 - Input torque
2 - Drive is from input shaft through helical gears to forward axle gearing.
3 - In low range, the planetary gearing is introduced in the drive system, between the ring gear and wheel differential (both axles).
4 - Drive is from output shaft side gear to rear axle gearing.
5 - Inter-axle differential NOT operating.

Dual Range Tandem Shift System

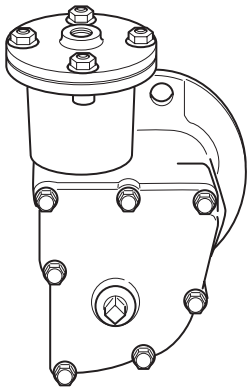
Range selection is accomplished by an air shift system and is driver-controlled through a cab-mounted air control valve.

The control valve operates two shift units (one for each axle) which mechanically engages or disengages the planetary gearing.

For operation description, refer to Shift System section in this manual.



Forward Axle Shift Unit

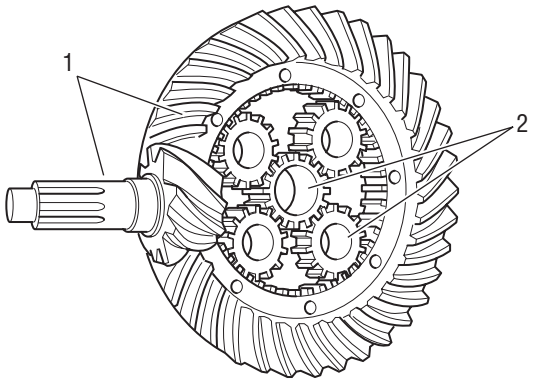


Rear Axle Shift Unit

Description and Operation

The Planetary Double Reduction Tandem Axle shares its basic design concepts and many components with the Dual Range Tandem. The principle variation is the permanent engagement of the double reduction feature. A stationary sun gear, fixed in engagement with the low-speed clutch plate, replaces the sliding clutch gear and provides continuous double reduction operation in the same manner as the dual range axle when in Low Range.

Torque distribution and power flow is same as Dual Range Gearing in Low Range.



Planetary Double Reduction Gearing
1 - First Reduction: pinion and ring gear
2 - Second Reduction: planetary gearing

Dual Range Gearing

The gearing for each axle is a combination of a spiral bevel ring gear and pinion and a planetary unit.

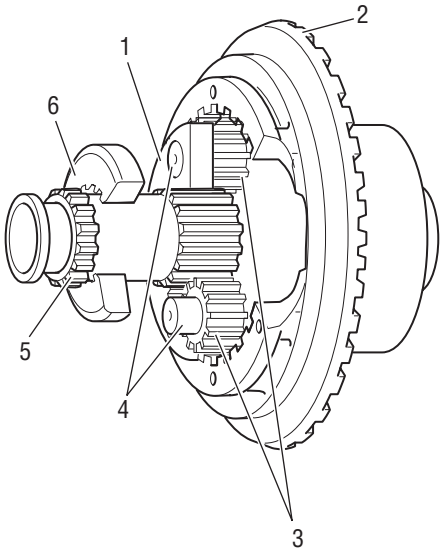
First reduction (High Range) is provided by the spiral bevel gearing.

Second reduction (Low Range) is through the planetary gearing. Four planetary idler pinions are confined within the ring gear and mesh with the ring gear internal teeth. The planetary gears rotate around a sliding clutch gear.

Each axle is equipped with a shift unit, which operates the sliding clutch gear to provide means for selecting the axle range. Range selection is accomplished through the movement of the sliding clutch gear in and out of engagement with the planetary pinions.

High Range

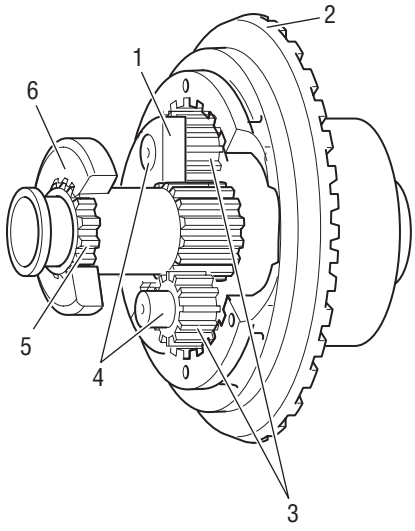
The sliding clutch gear is locked into the high-speed clutch plate and rotates as part of the differential assembly. The planetary pin-ions are stationary and the axle uses only the single reduction of the ring gear and pinion. Power flow is through the drive pinion, ring gear, differential unit and axle shafts.



1 - High-speed clutch plate
2 - RIng gear
3 - Planetary pinions
4 - Idler pinion pins
5 - Sliding clutch gear
6 - Low-speed clutch plate (bearing adjuster)

Low Range

The sliding clutch gear is shifted into engagement with the low-speed clutch plate (an integral part of the left-hand bearing adjuster). The sliding clutch is held stationary and the planetary pinions are forced to rotate around it. Power flow is now through drive pinion, ring gear, planetary gearing, differential unit and axle shafts. The axle uses two reductions to multiply torque. The planetary unit adds approximately 36% more reduction to the primary gear set. Torque is multiplied on an equivalent basis.



1 - High-speed clutch plate
2 - RIng gear
3 - Planetary pinions
4 - Idler pinion pins
5 - Sliding clutch gear
6 - Low-speed clutch plate (bearing adjuster)

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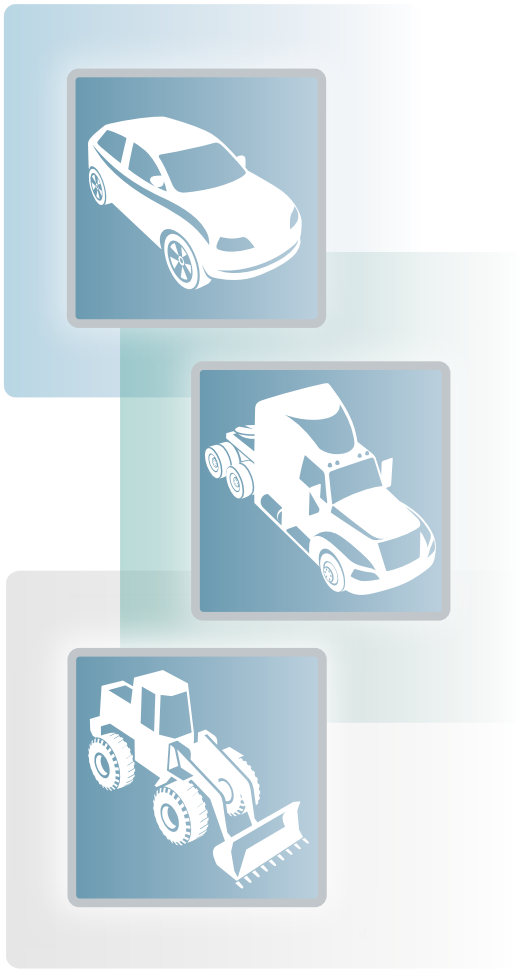

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